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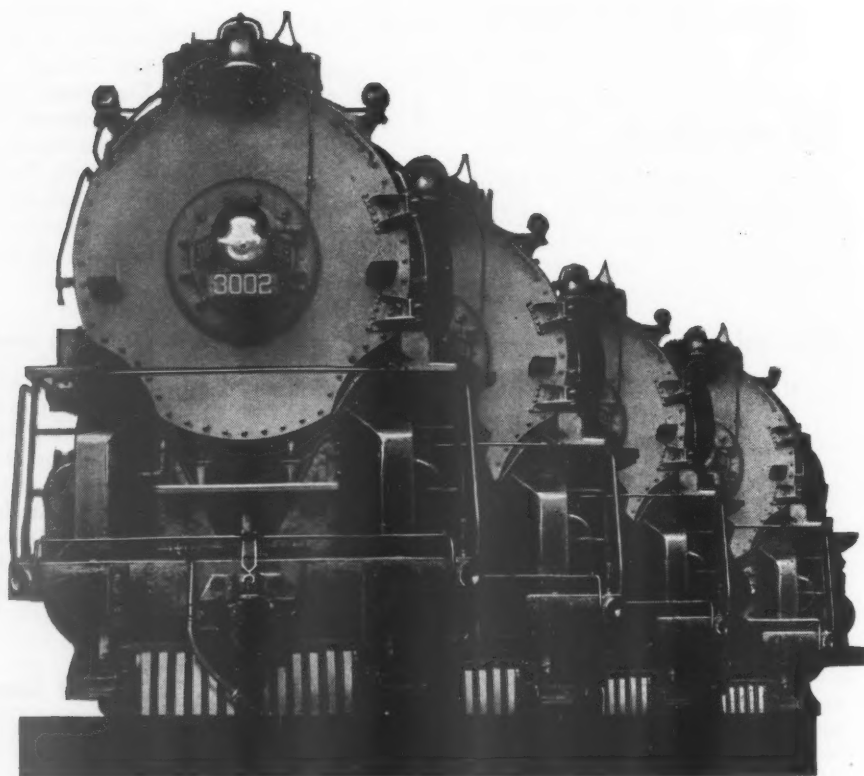
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Railway Mechanical Engineer

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October - 1933

Report of Road Tests of AB Freight Brake

THE demonstration tests of the new AB freight brake equipment, developed by the Westinghouse Air Brake Company and the New York Air Brake Company, were made by the American Railway Association on the Pennsylvania Railroad near Johnstown, Pa., starting on March 17, 1933, and being completed on April 11. This series of tests was made for the purpose of (1) checking the operation of the new AB equipment with the operation of the FC-3A equipment as developed during the A.R.A. tests on the Southern Pacific Lines in Oregon; (2) investigating the operation of the new AB equipment with trains containing both empty and loaded cars; (3) investigating the effect of the AB equipment when operated in trains composed both of AB and K equipments, and (4) determining whether the AB equipment would meet road conditions safely in service.

The demonstration tests of the AB equipment were made on the Sang Hollow Extension Branch, Pittsburgh division, Pennsylvania Railroad, approximately five miles west of Johnstown. The test track was approximately 13 miles in length. In the immediate section where the stops were made it contained curves which varied from 57 min. to 2 deg. 17 min. All level-road tests, except the running release tests, were made in an easterly direction on a slightly ascending grade of 0.28 per cent. The running release tests were made in the opposite direction from the stopping tests on a slightly descending grade varying from zero to 0.28 per cent.

The grade tests were made in an easterly direction on the main line of the Pittsburgh division of the Pennsylvania between Gallitzin, Pa., and Altoona. The grade on this test track varies from between .98 per cent and 2.46 per cent, averaging approximately 1.8 per cent, with curves varying from 1 deg. to 9 deg. 15 min.

The schedule of tests may be divided into the following principal groups:

1—Level-road tests with 150-empty-car train with all AB brake equipment.

2—Level-road tests with 150-car train composed of mixed loaded and empty cars with all AB brake equipment.

3—Level-road tests with 150-empty-car train composed of 100 type AB equipments and 50 type K equipments.

4—Level road tests with 150 loaded cars with all AB equipments.

A summary of the report of the results of the Pennsylvania tests, made by Harley A. Johnson, director of research, to the Mechanical Division of the American Railway Association

5—Grade tests with 100 loaded cars and also with 150 empty cars, both equipped with all AB equipments.

The level road tests in the final schedule of tests included service applications with both straight service and split full-service reductions, straightaway emergency tests, break-away emergency tests, emergency following service applications and running release tests.

The cars used in the test train, which were equipped with the new AB freight-brake equipments, were new Pennsylvania X-29, 100,000-lb. capacity box cars, except for car No. 1 and car No. 150, which were the Westinghouse Air Brake Company's dynamometer car, and a Pennsylvania cabin car, respectively. The new box cars in the test train were equipped with Waugh-Gould No. 403 and National M-17 draft gears and also the type E couplers. The average weight of the empty cars was approximately 47,000 lb. The average length of brake pipe per car was 49 ft. 3.5 in. The neutral length of the train (without slack bunched or stretched) from the trip at the locomotive cab to the rear end of the 150-car train was 6,766 ft.

Instrument cars were spaced at 30-car intervals throughout the train. The Westinghouse dynamometer car was instrument car No. 1 and the Pennsylvania cabin was instrument car No. 150. Instrument cars Nos. 30, 60, 90 and 120 were the same type of box car as used throughout the train. These instrument cars were each equipped with an automatic recording shock instrument, gages, telephone, stove and other conveniences for the use of the instrument-car operator and observers. Portable dynamometers were located between cars Nos. 74 and 75, 124 and 125, and between 147 and 148 for measuring the forces at these points.

One hundred fifty of the new box cars having AB brake equipments were loaded with locomotive sand for

the loaded car train tests. The average gross weight of these cars was 82.6 tons per car when loaded, and the average braking ratio when loaded was 16.75 per cent, compared to 59.2 per cent when empty, based on 50-lb. cylinder pressure. In the 150-loaded-car train tests there were actually 139 loaded cars braking as loads and 11 instrument cars braking as empties. The Westinghouse dynamometer car located directly behind the locomotive was changed from an empty-car condition to a loaded-car condition by cutting out one of the two brake cylinders used in the empty-car tests.

In the mixed-equipment tests when 50 standard K equipments were operated with 100 new AB equipments, box cars of the same type and capacity were withdrawn from regular service to make up the group of 50 standard K equipments. Before placing these cars in the test train the cars were inspected, brake equipments cleaned and tested, brake levers checked and such adjustments made that these cars would have the standard brake ratio of 60 per cent when empty.

Two Pennsylvania locomotives of the IIS class were used in the demonstration tests. Locomotive No. 4565, which was used next to the train in all tests, was equipped with a type H-8 brake valve and a No. 8 distributing valve. Locomotive No. 4345, which was used as the lead engine in all tests requiring more than one engine, was equipped with a type H-6 brake valve and a No. 8 distributing valve. Both locomotives were equipped with electric speedometers driven from the leading truck axle. The brake ratio of locomotive No. 4565 was 48.85 per cent, based on 50 lb. brake-cylinder pressure with the tender half loaded with coal and water.

Eighteen tests, consisting of 80 runs, were made with the 150-empty car train with the AB brake equipment. Seven of these tests consisted of service applications at various speeds to determine the speed from which maximum shock occurs; five tests consisted of emergency applications at various speeds to determine the speed from which maximum shock occurs; one test consisted of

emergency following service application at various speeds to determine the speed from which maximum shock occurs and one test consisted of an emergency application following a 20-lb. service reduction at 30 m.p.h., and four tests consisted of running release tests to determine the conditions under which a 150-empty-car train with AB equipment can be released following a service application without stopping the train.

Service-Application Stops—150 Empty Cars

The seven tests in the service application group consisted of three tests under minimum leakage conditions and four tests with brake-pipe leakage sufficient to produce a brake-pipe pressure gradient between the two ends of the train of approximately 10 lb. Three tests were made under both leakage conditions as follows:

1—Brake valve placed in first service position until the train stops.

2—Brake valve placed in first service position for 20 sec., followed by further service reduction to total 20 lb.

3—Ten-pound service reduction, then lap position.

The seventh test consisted of making 20-lb. straight service reductions at various speeds to determine the speed from which maximum shock occurs with brake-pipe leakage sufficient to give a 10-lb. gradient in brake-pipe pressure.

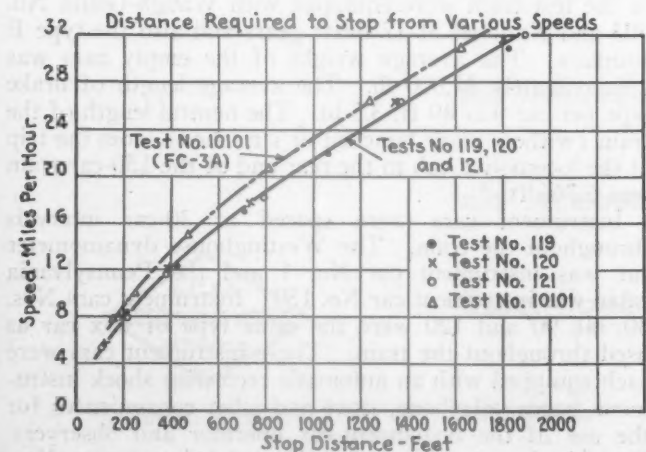
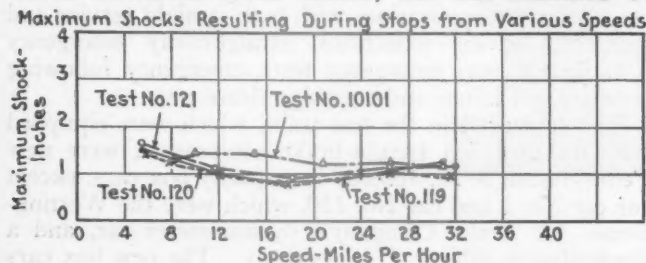
Reference has been made to the use of first service position on the brake valve. This brake-valve movement consisted of placing the brake-valve handle in the old holding position, which resulted in the initiation of a minimum service reduction of approximately 7 lb. followed by a gradual reduction in brake-pipe pressure to total 20 lb. in approximately 2 min.

All service-application stops with AB equipment, except two, were made with maximum shocks of less than the tolerable limit of 2 in.* The two stops which resulted in shocks slightly in excess of 2 in. were with 10-lb. and 20-lb. straight service reductions, with leakage sufficient to produce a 10-lb. gradient in brake-pipe pressure. In general, the maximum shocks with the service applications occurred at speeds of 5 to 6 m.p.h.

Curves showing the maximum shocks recorded and the stop distances at the various speeds under the several types of service applications are shown in Figs. 1 and 2. The results of the 10-lb. service reduction test made with the FC-3A equipment (Oregon tests) have also been included with these curves so that a comparison could be made between the two equipments, even though these equipments were tested on different trains. These curves show that the stop distance was shorter with the FC-3A equipment than with the AB equipment. At a speed of 20 m.p.h. the stop distance with a 10-lb. service reduction and minimum leakage conditions was approximately 770 ft. with the FC-3A equipment, compared to 890 ft. with the AB equipment. With brake-pipe leakage sufficient to produce a 10-lb. gradient the stop distance with a 10-lb. service reduction from 20 m.p.h. was approximately 760 ft. with the FC-3A equipment compared to 810 ft. with the AB equipment. The maximum shocks under these conditions were slightly higher for the FC-3A equipment than for the AB equipment, both being less than the tolerable limit of 2 in., except for the two trials mentioned in the preceding paragraph.

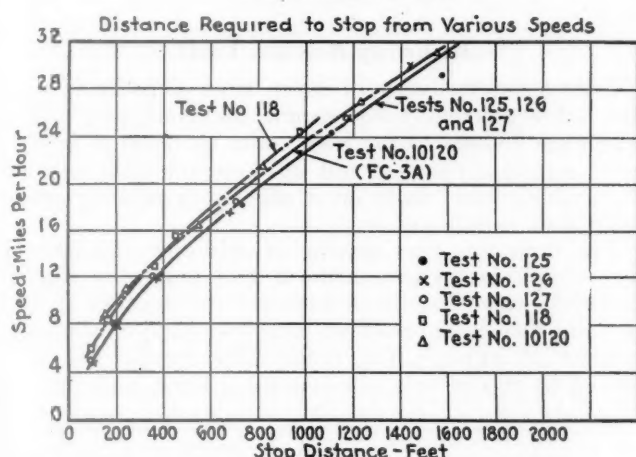
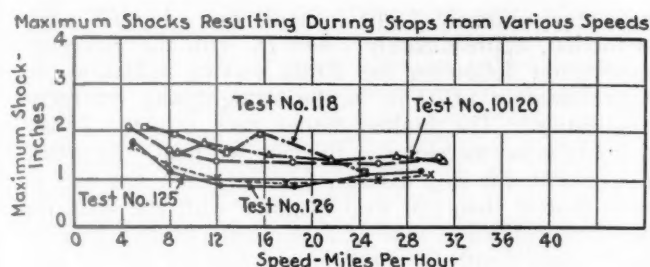
The service propagation time (time in seconds from brake-valve movement to service position to the instant the one-hundred fiftieth car starts to apply) with the AB equipment with minimum-leakage conditions, averaged 16.3 sec. in 18 trials, compared to 14.7 sec. and 113.5 sec.

*A shock which produced a movement of 2 in. the shock-recording instrument generally approximated 500,000 lb. buff or jerk. In the Southern Pacific tests it was found that shocks of 3 in. generally bent the coupler shanks and otherwise damaged the cars.



Test No. 119—Brake valve in first service position until train stopped.
Test No. 120—Split full-service reduction with brake valve in first service position for 20 sec., then full-service reduction.
Test No. 121—10-lb. service reduction and lap.
Test No. 10101—10-lb. service reduction and lap (FC-3A—Oregon tests).

Fig. 1—Service-application stops with AB brake equipment and minimum leakage conditions—150 empty cars



Test No. 125—Brake valve in first service position until train stopped.
Test No. 126—Split full-service reduction with brake valve in first service position 20 sec., then full-service reduction.
Test No. 127—10-lb. service reduction and lap.
Test No. 118—20-lb. service reduction and lap.
Test No. 10120—10-lb. service reduction and maintaining (FC-3A—Oregon tests).

Fig. 2—Service application stops with AB brake equipment and a 10-lb. gradient in brake-pipe pressure—150 empty cars

with the FC-3A and K equipments, respectively, in the Oregon tests. The length of brake pipe in the AB 150-car train was 7,395 ft. compared to 6,412 ft. for the brake pipe of the FC-3A 150-car train in Oregon, or an increase in length of 15.3 per cent. With brake-pipe leakage sufficient to create a gradient in brake-pipe pressure of approximately 10 lb., the service propagation time of the AB equipment in 16 trials averaged 14.6 sec. compared to 12.3 sec. with the FC-3A equipment in the Oregon tests.

Emergency Stops—150 Empty Cars

Five tests in this group consisted of critical-speed tests to determine the speed from which maximum shock occurs.

When the test train was turned over to the American Railway Association at Johnstown, March 17, 1933, as ready for test, the brake-cylinder card in the AB equipment was adjusted to produce a 7.2 sec. delay type of card in emergency application. This card is three-stage consisting of a 15-lb. inshot, followed by a 7.2-sec. delay period building up from 15 lb. to approximately 47 lb. through a $\frac{3}{32}$ -in. orifice, and then followed by a rapid build-up of pressure through a $\frac{1}{64}$ -in. orifice to a maximum of approximately 60 lb. in 9.5 to 10 sec. This card has a faster rate of development of pressure in emergency than the 15-sec.-delay card, which was found by extensive research in the Oregon tests to be desirable for long-train operation, and also a faster rate of development of pressure than the FC-3 type card, which had approximately a 6.5-sec.-delay period and resulted in excessive shocks sufficient to cause derailment and damage in the Oregon tests.

In making the previous statement it must be remembered that the shocks developed in a long freight train during emergency application do not depend solely upon

the rate of development of brake-cylinder pressure upon each individual car. The propagation time of the emergency action throughout the train is just as important a factor as the rate of build-up of cylinder pressure on each individual car. If the propagation time is lessened a more rapid build-up in cylinder pressure can be used without increasing the intensity of the shock, other conditions being the same. The propagation time of the FC-3 equipment in the Oregon tests average 9.3 sec., while the propagation time in the AB tests at Johnstown averaged 8.5 sec. for the 150-car train. The three types of cards referred to are shown in graphical form in Fig. 3.

The locomotive brake-cylinder cards, which were used with each type of car brake-cylinder card, are also shown on Fig. 3. The locomotive brake-cylinder card which is shown as used with the AB 15-sec.-delay car card, was also developed after extensive research in the Oregon tests and was found to be the most suitable for long-train operation, both with empty cars and with heavily-loaded trains. The locomotive card used with the AB 7.2-sec.-delay car card consisted of a continuous build-up at a rate to produce 50 lb. in approximately 10 sec., but in the actual tests the pressure began to show on the gage at 2 sec., followed by a continuous build-up to 50 lb. in approximately 13 sec. The locomotive card used with the AB 15-sec.-delay car card consisted of a continuous build-up to 30 lb. in approximately 30 sec. In the actual tests pressure began to show on the locomotive gage at approximately 13 sec., building up to 33 lb. in approximately 30 sec.

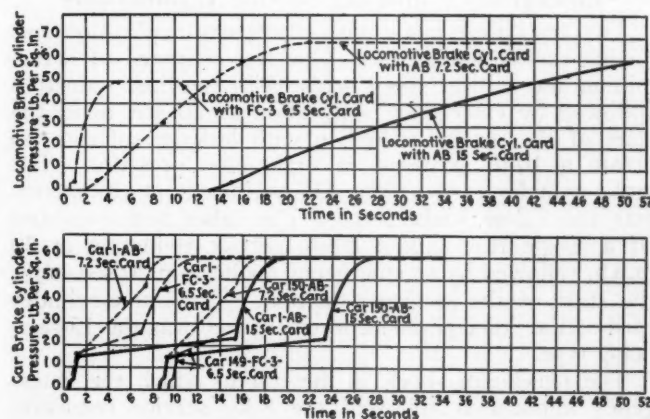


Fig. 3—A comparison of the emergency brake-cylinder cards produced by the FC3 and the AB brake equipments and the emergency locomotive brake-cylinder cards with them

It was found in the Southern Pacific tests in Oregon that the curves showing the development of brake-cylinder pressures do not show the true relationship between the retarding forces on the cars and the locomotive. Graphs were then prepared showing retarding forces of the cars and locomotive expressed in terms of per cent brake force instead of brake-cylinder pressure. These graphs are shown in Figs. 4 and 5. It is evident that the long heavily loaded train and not the long empty-car train governs the rate at which brake-cylinder pressure should be developed on the locomotive in emergency application, so that the locomotive will not retard too rapidly, causing differences in speed between the two ends of the train which result in heavy shocks with damage to equipment and lading.

Five emergency application tests were made with the 150-empty-car train with AB equipment. Two of the tests were straightaway emergency applications at various speeds to determine the speed from which the maxi-

imum shock occurs with both the 7.2-sec.-delay card and the 15-sec.-delay card under minimum leakage conditions. The maximum shock with the 7.2-sec.-delay card was 1.85 in., and with the 15-sec.-delay card, 1.69 in. The results of the same test with the FC-3A equipment in the Oregon tests showed a maximum shock of 1.44 in. (jerk). Curves showing the maximum shocks and stop distances for the various speeds with the three equipments are shown in Fig. 6.

The stop distance in emergency application was shorter with the AB 7.2-sec.-delay card than with the AB 15-sec.-delay card, or with the FC-3A equipment. The stop distance in emergency at 20 m.p.h. was 325 ft., with the AB 7.2-sec.-delay card compared with 455 ft. and 470 ft. with the AB 15-sec.-delay card and the FC-3A equipment, respectively.

The other three emergency application tests with the AB equipment consisted of determining the critical speed with brake-pipe leakage sufficient to produce a 10-lb. gradient in brake-pipe pressure with the 15-sec.-delay card, with 90 lb. brake-pipe pressure with the 15-sec.-delay card, and with break-away emergency application with the 7.2-sec.-delay card. The maximum shocks were 1.77 in. at 5.2 m.p.h. with the 10-lb. gradient in brake-pipe pressure, 0.86 in. at 5.08 m.p.h. with the 90-lb. brake-pipe pressure, and 2.32 in. at 7.77 m.p.h. in the break-away emergency application test.

The emergency propagation time of the AB equipment averaged 8.4 sec. in 17 trials with the 150-car train compared to 7.9 sec., and 10.1 sec. with the FC-3A and K equipments, respectively, in the Oregon tests.

Emergency Following Service Applications

Two tests were made with emergency application following service application. One test consisted of determining the critical speed with 8-lb. service reduction followed by emergency application at 20 sec. after the start of the service reduction with leakage sufficient to create a 10-lb. gradient in brake-pipe pressure. The brake-cylinder card of the AB equipment in emergency was the 7.2-sec.-delay type. The other test consisted of a single run with a 20-lb. service reduction at 30 m.p.h. followed by an emergency application 20 sec. after the start of the service reduction. The brake-cylinder card of the AB equipment in emergency was the 15-sec.-delay type.

The maximum shock in the test in which the emergency application followed the 8-lb. service reduction was 1.60 in. at a speed of 10.48 m.p.h. The maximum shock in the second test (one run only at 31.95 m.p.h.) when an emergency application was made following a 20-lb. service reduction was 1.23 in. Curves showing the maximum shocks with these tests as well as with a split full-service reduction and a straightaway emergency application, and the stop distances at the various speeds, are included in Fig. 7. The stop distance at 32 m.p.h.

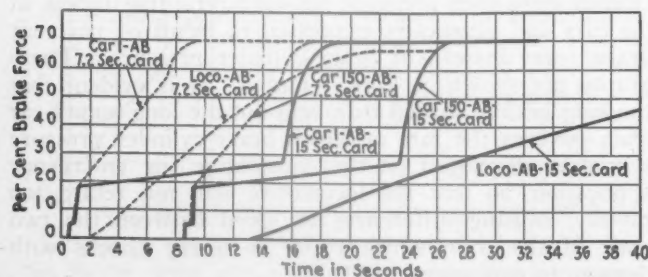


Fig. 4—A comparison of the per cent brake force in emergency with the two types of AB brake-cylinder cards and the corresponding locomotive brake-cylinder cards—Minimum leakage and 70-lb. brake-pipe pressure—150 empty cars

was approximately 1,840 ft. with the split full-service reduction, approximately 1,440 ft. with the emergency application following the 20-lb. service reduction, and approximately 1,070 ft. in the straightaway emergency application. The brake-cylinder card was the 15-sec.-delay type in emergency in the last two tests. Expressed in per cent, the stop distance in emergency was 41.8 per cent shorter than the stop distance with the split full-service application and 25.7 per cent shorter than the stop distance with the emergency following service application.

Running Release Tests

Four tests consisting of seven runs were made with the AB equipment to determine the conditions under which the 150-empty-car train could be released following a service application and still keep the train moving. These tests were made on a slightly descending grade from zero to 0.28 per cent.

The train was kept moving in only one trial when a service application was made at 28.4 m.p.h. by placing the brake-valve handle in first service position for 10 sec. and then in lap position until the speed of the train reached 15 m.p.h. The brake-valve handle was then moved to full release position for 10 sec. and then to

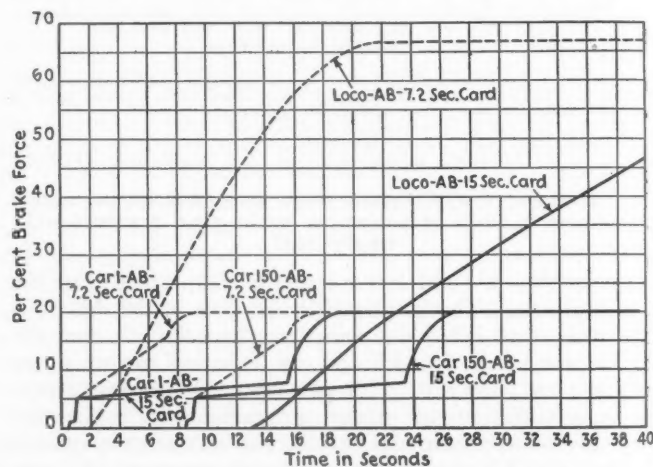


Fig. 5—A comparison of the per cent brake force in emergency with the two types of AB brake-cylinder cards and the corresponding locomotive brake-cylinder cards—Minimum leakage and 70-lb. brake-pipe pressure—150 loaded cars

running position to release the brakes. The engineman gradually opened the throttle after the start of the release, the speed of the train decreasing to a minimum of 8.5 m.p.h. and then gradually increasing. The maximum shock in the train during this test was 0.34 in.

Another run made under the same conditions, except that the release was started at 20 m.p.h. instead of 15 m.p.h., and that the throttle was kept closed during the service application and the release of brakes, resulted in the train stopping, although all instrument cars in the train were completely released at the time the train stopped. The maximum shock in this run was 1.06 in., occurring during the release operation.

Mixed Empty and Load Tests

Two groupings of loaded and empty cars were tested in the mixed empty and load tests. These consisted, first, of a train made up of 25 empties and 25 loads, 25 empties, 25 loads and 50 empties in the order named, and, second, 25 loads, 25 empties, 25 loads and 75 empties in the order named. The tests of both trains included stops from various speeds with 10-lb. service reductions with the minimum brake-pipe leakage, and both

10-lb. and split full-service reductions with brake-pipe leakage sufficient to produce a 10-lb. gradient in brake-pipe pressure. The maximum shocks varied from less than .92 in. in the case of the second train, stopped by a 10-lb. service reduction with minimum leakage, to 1.45 in. in the case of the 10-lb. service reduction with the 10-lb. gradient in brake-pipe pressure on the first train. Stopping distances at 20 m.p.h. were 950 ft. with a 10-lb. brake-pipe pressure gradient, and 1,050 with the minimum brake-pipe leakage in the case of the first train. With the second train the distance was 960 ft. with the split full-service reduction, and 1,030 in the stop with a 10-lb. service reduction in both cases with the 10-lb. gradient of brake-pipe pressure. The service propagation time with the second arrangement of empties and loads averaged 17.6 sec. for the 150-car train (average of three trials).

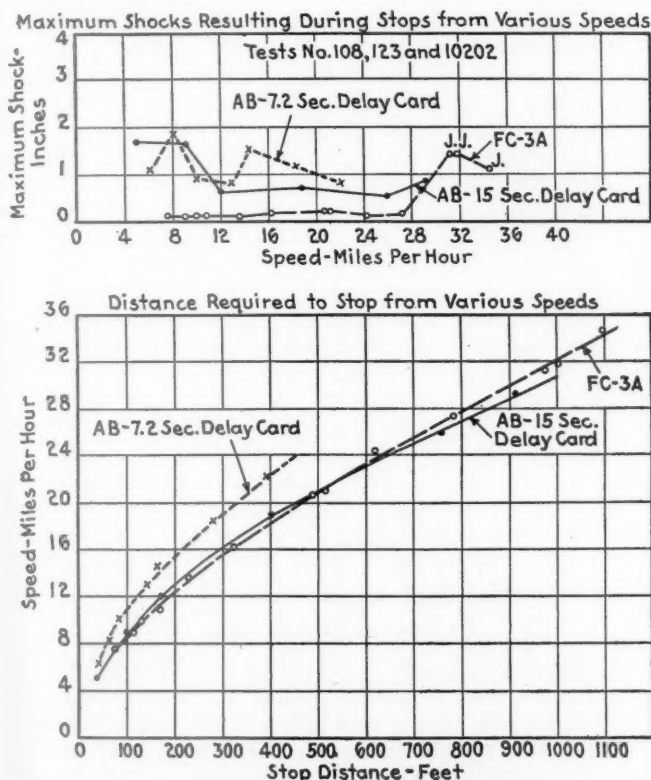


Fig. 6—Emergency application stops with AB equipment showing both 15-sec. and 7.2-sec.-delay cylinder cards—150 empty cars

The emergency tests included stops with straight-away emergency applications at various speeds, with both the 15-sec.-delay and the 7.2-sec.-delay cards for both the first and second arrangements of empties and loads. In addition to these tests stops from break-away emergency applications were made with both types of car cards on the first train. In the case of the first train the maximum shock recorded was 2.40 in. in the break-away emergency test with a 7.2-sec.-delay card as compared with .7 in. with the 15-sec.-delay card. With the second arrangement of empties and loads the maximum shock with the 7.2-sec.-delay card was a jerk of 2.23 in. in a stop from 25.56 m.p.h., which resulted in breaking a knuckle between cars Nos. 75 and 76. The dynamometer record on car No. 1 showed a squeeze of 70,000 lb. followed by a jerk of 350,000 lb. (1.5 in.). The maximum shock with the 15-sec.-delay card was 1.62 in. at 25.57 m.p.h., the dynamometer record showing a squeeze of 8,000 lb. followed by a jerk of 153,000 lb. (.47 in.), indicating a heavier reversal of slack with the 7.2-sec.-delay card than with the longer delay. Stopping

distances from 20 m.p.h. in the straightaway tests with the 7.2-sec.-delay card were 400 ft. for the first train arrangement and 410 ft. for the second, and with the 15-sec.-delay type card, 590 ft. for the first and 580 ft. for the second train arrangement. The stopping distances in the break-away tests with the first train arrangement were 435 ft. in the case of the 7.2-sec.-delay card and 585-ft. in the case of the 15-sec.-delay type card.

Mixed K and AB Equipments

Four types of 150-car trains were tested, each with a different arrangement of K and AB brake equipments. These were: (1) 25 AB, 50 K and 75 AB; (2) 50 AB, 50 K and 50 AB; (3) 100 AB and 50 K; (4) 50 AB, 25 K, 50 AB and 25 K equipments.

Service tests were made only on trains of the first and fourth arrangements. In the critical-speed tests of the first train the lowest maximum shock was recorded in the series using split full-service reductions with minimum brake-pipe leakage. This amounted to 1.06 in. in a stop from 7.83 m.p.h. The highest maximum shock was recorded in the series of stops with 10-lb. service reductions and a 10-lb. brake-pipe-pressure gradient, amounting to 2.11 in. in a stop from 6.67 m.p.h. In the first series mentioned the stopping distance from 20 m.p.h. was 980 ft. and, in the second, 770 ft. All of the service tests of the train with the fourth arrangement of brake equipments were made from speeds of 18 m.p.h. With a split full-service reduction and minimum brake-pipe leakage the stopping distance was 790 ft. With the same type of reduction, but with the 10-lb. brake-pipe-pressure gradient, the distance was 700 ft.; with a 10-lb. brake-pipe reduction the distance was 690 ft., and with a 20-lb. brake-pipe reduction, 635 ft., in both the latter cases leakage conditions being adjusted to the 10-lb. pressure gradient. The lowest maximum shock was the .92 in. in the 790-ft. stop, and the highest maximum shock was 1.55 in. in the 690-ft. stop.

The arrangement of the K and AB equipments in the first three trains grouped the K equipments in one block of 50 cars. It was not possible to make emergency stops in the entire speed range with any of these three trains, due to the excessive shocks resulting from the very rapid and uncontrolled development of cylinder pressure in emergency on the K equipments. The fourth grouping was then tested to determine if, with a maximum number of 25 K equipments in one block, it was possible to make all of the stops within the entire speed range with both the 15-sec.-delay and 7.2-sec.-delay brake-cylinder cards.

The emergency applications with both brake-cylinder cards were first tested with only a 100-empty-car train at approximately 18 m.p.h., then 10 additional cars were added in successive trials until the test train was built up to 150 cars. The maximum shock with each train in emergency application was greater for the 7.2-sec.-delay card than for the 15-sec.-delay card. For the 100-car train the maximum shocks were 1.82 in. with the former and 1.55 in., with the latter, respectively; for the 110-car train, 1.75 in. and 1.69 in.; for the 120-car train, 2.12 in. and 1.83 in.; for the 130-car train 2.40 in. and 1.86 in., and for the 140-car train, 2.75 and 2.04 in., respectively.

Since the shocks with the 140-car train of mixed equipments did not exceed 3 in., the 150-car train was submitted to the critical-speed emergency test with both types of cards. The critical-speed zone with the 15-sec.-delay card was from 6 to 9 m.p.h., the maximum shock being 3.31 in. at 6 m.p.h. The critical-speed zone with the 7.2-sec.-delay card was from 5.93 to 16.53 m.p.h. with a maximum shock of 3.25 in. at 5.08 m.p.h. Only

two runs were made on the upper side of the critical speed zone with the 7.2-sec.-delay card; the first run at 18.18 m.p.h. resulted in a buff of 705,000 lb. on car No. 1 dynamometer, and the second at 16.53 m.p.h. resulted in a buff of 860,000 lb. It was not deemed advisable to search out the shocks in the zone from 5.93 to 16.53 m.p.h. due to the rapid rate of increase in the buff as the speed decreased to 16.53 m.p.h. The shocks in general were greater with the 7.2-sec.-delay card than with the 15-sec.-delay card.

The stop distance in emergency application was shorter with the 7.2-sec.-delay card than with the 15-sec.-delay card in the AB equipments. From a speed of 18 m.p.h. the stop distance was approximately 240 ft. for the

tests with the 15-sec.-delay car card. In the second test the locomotive brake-cylinder card consisted of a 4-sec. delay, followed by a continuous build-up in pressure at a rate which will produce 30 lb. pressure in approximately 30 sec.

This decrease in the delay or hold-back period of the locomotive brake-cylinder pressure build-up increased the maximum shock in emergency application from 1.17 in. to 1.72 in., without materially decreasing the stop distance. The stop distance in emergency application from 20 m.p.h. was approximately 655 ft. with the FC-3A equipment, 700 ft. with the 4-sec.-delay locomotive card and 710 ft. with the 13-sec.-delay locomotive card. The maximum shock in emergency application with the FC-3A equipment was 0.8 in.

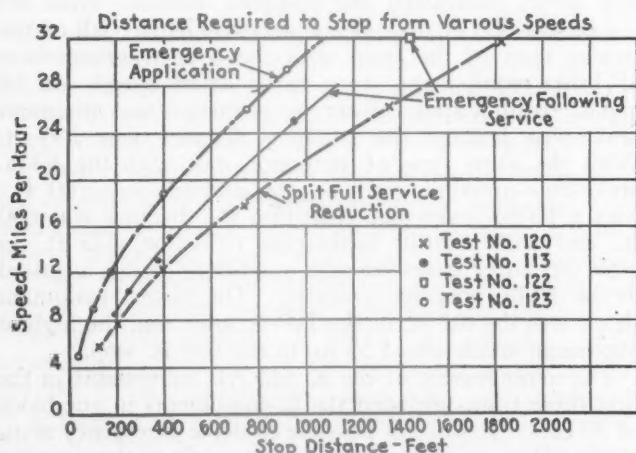
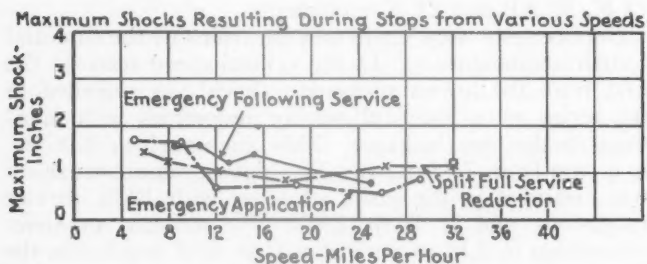
Grade Tests

Two grade tests were made with the AB brake equipment on the main line of the Pennsylvania between Johnstown and Altoona. The grade from the summit to Altoona is approximately 12 miles in length and averages approximately 1.8 per cent, with a maximum of 2.46 per cent. The first test consisted of taking a train of 100 loaded cars weighing approximately 8,000 tons, all with AB equipments, down the grade. The time-table restriction of the Pennsylvania on this grade is 7,200 tons and 125 cars. The train was handled satisfactorily even though the engineman delayed making the first automatic brake application until the entire train was on the grade and then graduated on the brakes in steps with the speed reaching a maximum of 30 m.p.h., before it started to decrease. After the speed decreased to 13 m.p.h., the speed was kept within the range from 13 to 19.5 m.p.h. The second grade test consisted of taking a train of 150 empty cars with all AB equipment down the same grade. The train was handled satisfactorily, the maximum speed variation being from 10 to 19 m.p.h. There were practically no shocks in either run down the grade.

General Conclusion

In conclusion, it may be stated that the AB equipment would meet road conditions safely in service. During the Johnstown tests it was not necessary to make any adjustments or changes in the AB equipment on account of the equipment failing to function as intended. During the 24 days of actual testing of the AB equipment there were no cases of undesired emergency application or failure to release. When the K equipment was mixed in the same train with the AB equipment the operation of the AB equipment improved the operation of the K equipment in both application and release.

STRANGERS TO TRAIN TRAVEL.—While talking to newspaper reporters at Dallas, Tex., a few months ago, George C. Smith, general traffic manager of the Missouri-Kansas-Texas, said that one of the reasons why the railway was running popular-price excursions was to educate young people to the comforts of train travel. At least 30 per cent of the present younger generation, he said, had never been on a train, and therefore accepted the discomforts of automobile and bus travel as a matter of course. The statement received wide publicity, and in the case of an instructor in a Texas college, it apparently aroused some skepticism. The instructor decided that she would check up on it. Accordingly, she put the question, "Have you ever ridden on a railroad train?" to all the students at the college, with results which surprised her but not Mr. Smith. Replies were not received from the entire enrollment of the school, but of the replies which were received, 25.9 per cent answered the question in the negative. Mr. Smith's estimate of the number of young people who are not train-conscious seems to have been borne out still further by the results of similar surveys made in two grade schools. In one, 70 per cent of the pupils had never ridden on a railroad train, while in the other, 45 per cent had never had this experience.



Test No. 120—Split full-service reduction—Brake valve in first service position for 20 sec., then full service.
Test No. 113—8-lb. service reduction followed by emergency (7.2-sec. card) at 20 sec.
Test No. 122—20-lb. service reduction followed by emergency (15-sec. card) at 20 sec.
Test No. 123—Emergency application with 15-sec.-delay card.

Fig. 7—A comparison of service application, emergency following service and emergency application tests with AB brake equipment and minimum leakage conditions—150 empty cars

former and 320 ft. for the latter. The stop distance with a split full-service application with the same train at 18 m.p.h. was 790 ft., with minimum leakage, and 700 ft. with the 10-lb. gradient in brake-pipe pressure.

One emergency test was made at 9 m.p.h., with the fourth grouping of cars, with alternate K brakes cut out in the zone from car No. 51 to 75. Emergency quick action did not carry through to the rear end of the train, with a resulting shock of 4.10 in. and car No. 148 knocked off center.

AB Brakes on 150 Loaded Cars

The two tests of the 150-loaded-car train consisted of critical-speed emergency applications with the 15-sec.-delay car brake-cylinder card and with two different types of brake-cylinder cards on the locomotive. In the first test the locomotive brake-cylinder card consisted of a 13-sec. delay followed by a continuous build-up in pressure at a rate which would produce 30-lb. pressure in approximately 30 sec., which was the card used in all

Real Objective of the Mechanical Department*

THE General Manager had received his higher education entirely in the "University of Hard Knocks." Possessing a strong personality, he might have made fair progress, even if he had been content only to do things in the approved manner as he found them. He preferred, however, to reason out the "why" of so doing, in the attempt to justify the prevailing methods and practices. Traditions meant little to him unless he could demonstrate their soundness. Incidentally, he came up through locomotive service and mechanical-operating supervisory positions. He was a careful reader of railroad technical periodicals.

"How can the mechanical department be of greater assistance to you in improving operation and strengthening the position of the railroad?" I asked.

Service to the Customer

"In general," he replied, "there are four principal departments in railroad operation—transportation, traffic, engineering and mechanical. The railroad has only two things to sell, passenger transportation and freight transportation. The difficulty is that the different departments in the organization are prone to think that they are ends in themselves. Take the mechanical department, for instance. It is not enough for an employee to do his job just well enough to get by and so that he will not be involved if an accident occurs.

"The car inspector, as an example, is quite likely to feel that his job is done when he has seen that the car will operate safely over the next division. This is not sufficient by any means. The car may get over the division safely, but because of defects which the car inspector should have had corrected, it may be unnecessarily delayed for repairs, or the lading may be damaged, although the car may have been subjected only to normal handling. In many instances the consignee is more disappointed when he receives a slightly damaged consignment than if he had not received it at all."

The General Manager proceeded to point out that the car inspector might religiously live up to all of the requirements of safety, and yet let cars get by possessing defects which might cause damage to the contents, or unnecessary delay to the shipment.

"Can't you check this up from the complaints you receive from the consignees?" I asked.

"Not with any very great accuracy," replied the General Manager. "Most people hesitate to make complaints, probably largely because of the inconvenience involved in so doing. I doubt if we hear from one-tenth of those who would be justified in making complaints. What they will do, however, is to divert their shipments to some other road or some other type of transportation.

"It seems to me," continued the General Manager, "that the mistake is in the mechanical department employees thinking that that department is an end in itself. It is not enough that the equipment be maintained in such condition as to operate safely, but it must be in such condition that the consignee will be pleased with the service which is rendered. The railroad must hold its business. If it loses out in this respect, of what use is the mechanical department, or any other department, for that matter? The great problem, as I see it, is to

* The third of a series of interviews with officers of other departments commenting in a constructive way upon the possibilities of the mechanical department.

Constantly changing conditions necessitate every employee of every department continually thinking in terms of satisfactory service to the customer

get every employee to realize the importance of doing his work in such a way as to please the customer. In this way only can the business be held and increased."

Passenger-Train Handling

"Can you make your meaning more clear by giving me another illustration?"

"Yes, quite decidedly," he replied. "Many passenger engineers seem to think that their task is to get the train over the road on schedule, regardless of the comfort or convenience of the passenger. After all, the proper handling of a train is not just a job, but an art, in which a real craftsman can take great pride. It is all wrong to have the passengers receive unnecessary jolts because the engineer keeps his air on until his train comes to a dead stop. By using his air properly it is easily possible to stop the train in such a way that the passengers will hardly notice it. If the engineer will begin the release of the brakes before the train stops, the jolts to the passengers caused by the surging of the car body on the trucks will be avoided and the slack thereby provided will enable the engineer to start the train without roughness or inconvenience to the passengers. This may all sound simple and old stuff to you, and yet the fact is that many engineers who have run on passenger trains for years take so little interest in handling the train to please the passenger and administer to his comfort, that they cheerfully go on without realizing that they are constantly irritating the travelers or are even driving business from the road.

Concealed Damage to Freight

"You can carry the same thing over into freight operation," continued the General Manager. "The engineer may get his train over the road on schedule time. He may even do this in spite of having a break-in-two. He feels that he has done his full duty if there is no delay in reaching the terminal. He may have handled the train so roughly, however, that there is more or less concealed damage to the lading. Because there can be no positive check on this and because he gets by without criticism, he may feel that he has performed his task satisfactorily. Those of us, however, who have to settle the loss and damage claims realize full well that the railroad not only loses financially from such handling, but that the consignee is irritated and disgusted, and frequently will go out of his way to hand his business over to some other agency."

"You have developed a strong fundamental philosophy," I said, "which should be instilled into the mind of every employee. Can you sum it up in a simple illustration?"

"I can," replied the General Manager, "but if you were to publish it, it might disclose my identity and I

do not want to hurt the feelings of any of my associates. After all, they are giving me fine co-operation and we are proud of the service we are giving the public. Let me attempt to sum it up, however, in this way. Too frequently we are slaves to rules or traditions. Conditions are more or less constantly changing and practices which were desirable and safe even a few years ago, may be clearly out of date now. It seems to me that,

as I have already indicated, employees of every department should work not for the particular ends of that department, but to render such a high grade of transportation that our clients will be thoroughly well satisfied and pleased. In doing this, however, we must constantly check up and reorient our thinking so that we can readily meet the changing conditions and new requirements."

Welded Steel Diesel Structures*

By Everett Chapman†

ONE of the factors which has prevented the Diesel engine from assuming its rightful place as an important prime mover in transportation units has been its excessive weight. The transportation field, including marine and railroad work, has been definitely closed to the Diesel engine because of its usual specific weight ratio ranging from 40 to 250 pounds per hp. Many successful applications have included only the most probable ones. The possible and likely applications, such as main-line passenger and freight service on the railroads, have been untouched.

A great deal of the weight involved in a Diesel engine is intimately connected with that part of the structure—the crankcase—which functions to connect the main gas load with its reaction point, the main bearings. The combination of high combustion pressures and large piston diameters results in loads of large magnitude. The strict requirement of structural rigidity, coupled with the fatigue nature of the load, demands that the usual cast material be worked at low stresses, which results in the excessive weight figures that are usual practice today. The tension nature of the load, imposed on a material that is not well suited to tension loading, results in a composite structure consisting of steel tie rods connecting the main bearings with the cylinder heads. These rods are in turn surrounded by a cast-iron structure which supplies the necessary rigidity for minimizing vertical deflection due to the gas loads and the horizontal components resulting from the inertia loading of the crank pins and rods.

The first step in the reduction of the weight of the usual arrangement naturally contemplates the use of steel instead of cast iron as the structural material. Steel, with a modulus of elasticity of 30,000,000 in contrast to cast iron with a modulus of 12,000,000, can provide a structure of similar section working at the same stress as the old one, but with only 40 per cent of the deflection. Turning this another way, it means that the steel structure can be worked at two and one half times the stress of the cast-iron structure, and yet retain the same rigidity. Care must be taken in the application of this figure in actual design work, since only those areas which are axially loaded can be reduced by any such amount. In the re-design of members subjected to bending, it is the moment of inertia of the section that is reduced by 40 per cent, and this new value is used in the re-design of the section. The

Welding makes available the high elastic modulus of steel for Diesel crankcases. This, with the flexibility of metal distribution which welding permits, has made it possible to build engines weighing less than 10 lb. per hp.

other physical characteristic of steel which enables a lighter-weight construction is its higher endurance limit as a fatigue-resisting material. Steel's higher ultimate strength is not a controlling factor since the engine must not break. Its higher yield point is of no advantage because the structure is useless if a permanent set occurs. Its superior ductility is important only as an index to the cleanliness of the steel. It is, therefore, obvious that the modulus of elasticity and endurance limit of steel are the only two factors that permit reduction in the weight of a Diesel engine crankcase.

Many attempts, accompanied by a few successful results, have been made to execute the light-weight Diesel crankcase in cast steel. But here again is an inhibiting factor in that cast steel will not flow in sections as thin as cast iron. Thus, the limitations of this manufacturing method legislate against any appreciable weight reduction.

The only alternative, then, is the use of rolled steel in the form of plates and shapes to build up the desired structure. To join the components, riveting is out of the question because the non-homogeneous and semi-rigid joints will not stand up under the severe service of the Diesel type of loading. In contrast, welding is eminently suited as the method of fabricating the rolled steel crank case.

Any questions that may be asked on the application of welding to Diesel engine crankcases center about two prime requisites, stiffness and endurance life, plus a secondary factor—corrosion-resistance—which affects only those marine installations where salt water is used as a cooling medium.

Questions concerning structural rigidity are answered by the fact that steel is the stiffest commercial material

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known to man. Further, the flexibility of the welding process enables the designer to use economical, efficient sections that have been impractical in other manufacturing methods. Thus, the matter of requisite rigidity is controlled entirely by the designing department. The intelligent designer who will delve into the possibilities of welded steel construction will find that the flexibility of the process enables him to go further in exercising his ingenuity than any process he has ever used. Theoretically perfect distribution of the material is limited only by the designer's ingenuity and those features of the old construction which are incapable of change.

The problem of endurance life can be rather simply stated although the subject as a whole is somewhat involved. In handling the severe loading conditions encountered in Diesel engine work over an equitable period of time, it is necessary to study thoroughly the

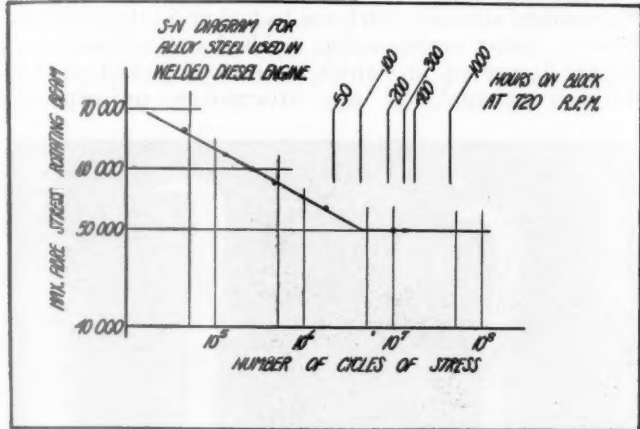


Fig. 1—S-N diagram for alloy steel used in the welded Diesel crankcase

mechanism of fatigue failure. The essence of the matter is that the stress range through which the component materials can be repeatedly stressed indefinitely without causing failure must be known. The maximum stress in the structure, wherever it occurs, must be under the known safe value. A low average stress as usually calculated cannot possibly guarantee an indefinite service life. It is the maximum stress which governs. A point of maximum stress may lurk in a hidden corner with too sharp a radius. It may exist in the bottoms of small tool marks. It may be present at undercuts unconsciously made during the welding process. It may be found at any small blow-holes or porosity in the materials. In particular, in the welding process, points of maximum stress always exist around an improperly designed welded joint. In an otherwise

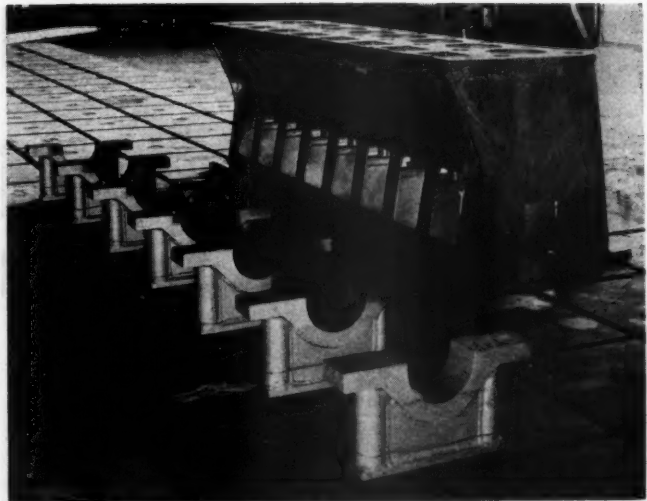


Fig. 3—A welded crankcase with bearing grids

perfect design, satisfying the rigidity requirements for successful functioning of the engine, the only thing that will break the structure subjected to repeated load is the existence of a hidden, minute defect in contour which multiplies the average stress condition by a factor of five, six, or even more. Points of high local stress are evident only as fatigue failures. Such points of high stress occur over such small areas that they have no influence on rigidity. Ductility cannot operate to alleviate a high stress condition as it does in statically-loaded structures, since this phenomenon requires a permanent deformation which is inadmissible in a crankcase that must preserve main bearing alignment.

Fig. 1 is a diagram depicting the repeated stress performance of an alloy steel which has been found most applicable to welded steel crankcases. It is an alloy steel of low carbon content and, therefore, well suited for welding. The curve shows it to have an endurance limit (as determined on a rotating-beam machine) of 50,000 lb. per sq. in., as contrasted with the equivalent value of 30,000 lb. per sq. in. for ordinary mild steel plate. A definite limiting range of stress at which the material will function for an indefinitely large number of reversals has been proved to exist for all materials. If the engine is not to fail prematurely but is to serve indefinitely, the product of the average working stress and the stress concentration factors (always introduced during fabrication) must not exceed this safe stress range—50,000 lb. per sq. in. in this case.

Stress factors of almost any magnitude can exist in a structure. A round hole in a body of material will raise the stress in its locality by a factor of 2.7. A



Fig. 2—A photo-elastic study of stress distribution—Left: Metal of the joined parts not fused—Center and right: A comparison of fillet forms



Fig. 4—Winton two-cycle Diesels with welded-steel structures

round hole on the surface of a material will raise the stress three times. These factors are not serious since the demands of rigidity will call for average stresses which, when multiplied by these factors, will not constitute a source of worry. The serious type of stress concentrations, against which the designer must guard diligently, are those exemplified by sharp corners and re-entrant angles. Mathematically, the stress concentration factor which exists at a corner or re-entrant angle is inversely proportional to the radius of curvature of the corner. If it were practically possible to achieve a perfectly sharp corner, the stress theoretically would be infinite.

While it is practically impossible to machine a corner with a zero radius, there are many types of welded joints in which the radius is nearer zero than can ever be approached by machining. Concentrations of this nature cannot be tolerated. The left illustration in Fig. 2 illustrates, photo-elastically, the stress distribution around an all too common type of welded joint. When two plates are superficially welded together, either by two welds whose roots are not fused together or by fillet welds merely laid in the corners, there is an unwelded boundary on the interior of the joint. This crack is an integral part of the contour of the joint and has a tremendous influence on the stress distribution. This condition can be simulated elastically by cutting, from a piece of Bakelite, the contours of the joint, including the internal crack. This specimen, when loaded and viewed by polarized light, shows the stress distribution that would exist around a similar welded joint. The concentrations which exist in the actual welded joint are even more severe. The saw blade used to cut the internal crack has a finite width, whereas the smallest dimension of the crack in the welded joint is practically zero, due to the tremendous contracting forces exerted by the cooling weld metal. Concentrations of this nature in poorly designed welded joints have broken more welded structures than any other single cause. Such joints will function properly in statically loaded structures, since the high ductility of the weld metal can allow sufficient plastic deformation, under high load, to correct the contour. They are suicidal, however, where the structure is subjected to repeated stress.

Another type of notch effect which may occur in a welded structure, and is a typical example of the things a designer and fabricator must guard against, is shown in Fig. 2. The center and right illustrations are a

photo-elastic study contrasting the stress distribution around a concave weld fillet with the stress distribution around a weld fillet with a triangular cross section. The triangular fillet shows marked concentrations at the ends of the weld. The concave fillet shows an evenly graduated stress, with the maximum value probably only two or three times that of the average stress. The concentration factor at the ends of the triangular weld can reach dangerous values. While the triangular-shaped weld fillet has more throat area and, therefore, a lower average stress, the maximum stress which exists is considerably higher than that around a concave fillet.

Other points to be considered are the condition of the weld, the endurance value of the weld metal, and the damage to the base metal by the high temperature of the welding operation. Heat treatment after welding is exceedingly important, not only to correct the damage occurring during welding, but also to remove the residual stresses which are locked up in the structure. There is direct evidence that residual stresses may reach 30,000 lb. per sq. in., which is nearly the yield point of ordinary material. If the structure is unfortunately

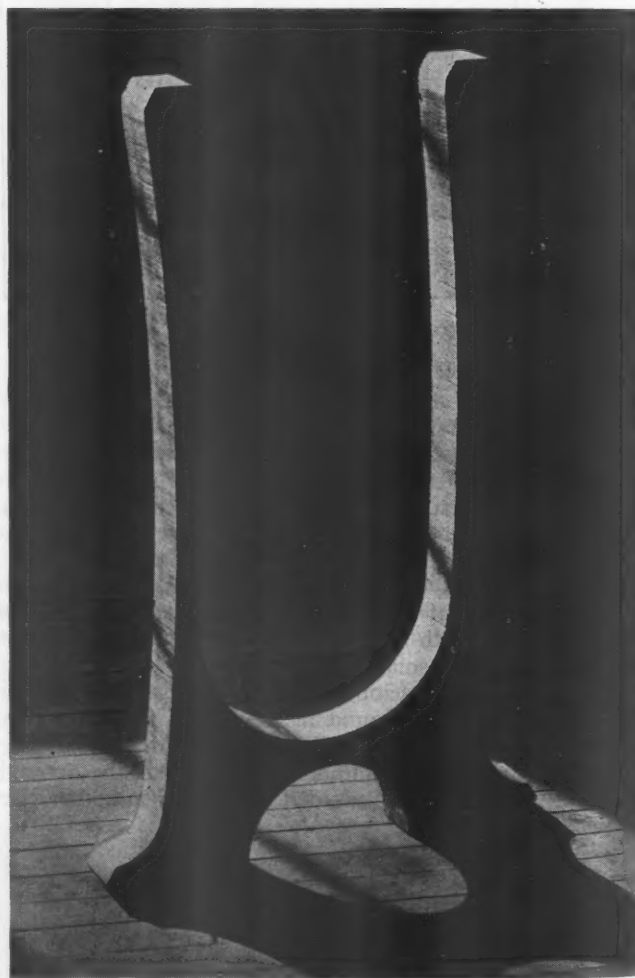


Fig. 5—A main-frame member for a welded-steel crankcase

loaded in the same direction as the residual stresses, there is no apparent strength. The other important phase of stress relief is that an unannealed welded structure will exhibit unseasoned properties worse than the greenest casting ever encountered. It will warp and twist on the planer and boring mill to a degree that will render the structure useless. It will not hold its shape over any period of time. Undercutting is quite common with many electrodes in the hands of an inexperienced

enced welder. With an undercut and its attendant stress concentration occurring just at this damaged zone in the parent metal, failure under repeated stress is imminent and certain. Other types of stress concentration occur in welded structures and must be eliminated.

The general subject of corrosion resistance of the weldable materials can be amply covered by the statement that there are many weldable materials with remarkable resistance to salt water corrosion. The flexibility of the welding process enables incorporation of these materials in the structure, where they are necessary. The admirable record of wrought-iron hulls in salt water could be duplicated in the water jacket of a welded steel crankcase. The stainless steels, nickel-clad steel and other clad metals, are all possibilities. Two of the early welded engines were galvanized in the region of the water jackets and a two year record in salt water has shown them to be adequate.

The early welded crankcases were of tie rod construction, the welded steel case serving as a stabilizing medium for the tie rods. It is a common misconception that the tie rods take all the load. Tie rods, if they are screwed up and set properly by means of strain gages,



Fig. 6—The built-up single-cylinder unit

bring into play the rigidity of the crankcase. The material which is compressed when the rods are screwed up adds its flexural rigidity to the flexural rigidity of the rod. It is just as important in the case of tie rod construction to eliminate stress concentrations as it is in the case of an engine in which the gas load is carried entirely by a weld. The frame is subjected to the same alternations of stress whether the tie rods are in place or not. The only condition under which the frame can be entirely relieved of stress occurs with loose tie rods. The engine shown in Fig. 3 was built of low carbon welding quality steel with endurance values for an indefinitely repeated stress of 30,000 lb. per sq. in. The



Fig. 7—A flame-cut main frame for a V-type crankcase

weld metal used to join the components had an endurance limit of 28,000 lb. per sq. in. established by rotating beam test on all-weld metal specimens. It was then a matter of eliminating all undercuts, unfused welded joints, and surface discontinuities of any type, since it is easy, at an average stress of 5,000 lb. per sq. in., to incorporate a stress factor of five or six, which would legislate against indefinite service life. The crankcases weigh about 5 lb. per hp.

Fig. 4 shows an installation of the same general type of crankcase with the exception that the engine is two cycle and slight modifications were made in the case to take care of this feature. These engines form part of the Winton Engine Corporation's exhibit at the Century of Progress at Chicago, and have been in continuous operation since the opening of the fair, supplying power and light to the entire General Motors Building there. This installation, including generator and sub-base, has a specific weight ratio of 39 lb. per hp. The specific weight ratio of the engine itself is 20 lb. per hp.

To eliminate still more weight in steel crankcases, the construction of a case was initiated, in which the gas and inertia loads were carried entirely by the welded structure. With the tie rod type of construction, much material is not working effectively, especially if the tie rods are not set properly. In a completely welded unit, better distribution of the stresses can be achieved because of the monolithic construction. An experimental single-cylinder frame was built, embodying a main frame flame-cut from a plate of steel 2 in. thick. This model was subjected to strain-gage tests to determine the efficacy of the conception. Fig. 5 shows the main frame as cut out for the model test engine, and Fig. 6 shows the built-up single cylinder unit. The main frame was joined by welding to the top deck, into which



Fig. 8—The partially built crankcase

the cylinder-head studs were tapped. This frame showed satisfactory deflection and stress characteristics.

An effective method of determining points of maximum stress in a three-dimensional structure is to paint it with a varnish possessing a low modulus of elasticity and a low yield point. When a static load is applied to the structure, the varnish cracks at the point of maximum stress while the structure is only lightly loaded. The varnish method shows points of maximum stress with a single application of a load and the load at which the varnish cracks correlates a wealth of information about stress factors and fatigue performance. It is needless to say that the varnish will first crack at those points where experience dictates a large radius. It will crack at the contours of an improper weld. It will crack at the root of an undercut.

Based upon this experiment, construction was undertaken of a 1,000-hp. twin-six engine, in which the entire



Fig. 9—Further progress in the crankcase construction

gas load was carried by the welds. Fig. 7 shows the type of flame-cut main frame which was used. This frame transmits the gas load of one bank of cylinders past the gas load of the other bank of cylinders, and into the main bearings. The minimum weight design is one in which the material is loaded in straight tension. The flexibility of flame-cut steel plate in meeting this ideal condition is well illustrated by this frame member. The stub ends of the frame could not be run through to the top deck because the stagger of the connecting rods produced a 3-in. offset in each cylinder with respect to the cylinder in the other bank, which necessitated the use of a transition joint. Since the transition joint had a peculiar shape, more experimental work was done to determine an efficient design for the joint before proceeding with the engine. The experimental joint simulated the condition in the engine where the joint carries an impact load of 19,000 lb. The joint fractured outside the weld, through the plate, at a load of 212,000 lb. Tensile tests of such joints in conjunction with a coat of brittle varnish are very instructive.

Fig. 8 shows the crankcase partly finished. The top deck was welded to the transition plate with a single butt weld running the entire length of the engine on each side. The gas load of each cylinder is then carried through the butt weld at the top deck, and through the two transition joints to the main bearings. In the condition shown in Fig. 8, each weld, including the transition joints, was radiographed by means of radium to discover any imperfections, unfused joints or porosity that might have existed. The crankcase was also thor-

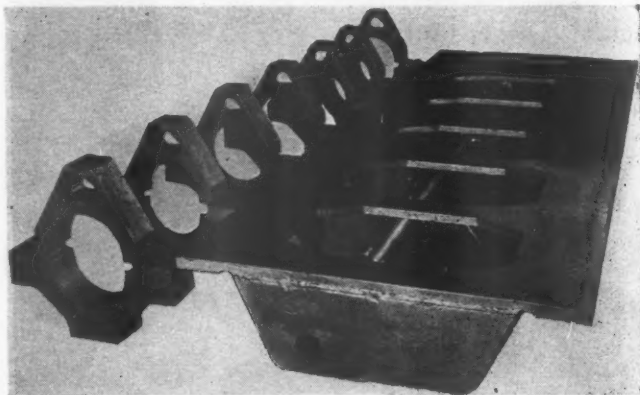


Fig. 10—The main bearing caps and oil pan

oughly inspected for undercuts and surface discontinuities. In the construction of two of these crankcases, it was not necessary to chip and re-weld any of the joints.

Fig. 9 shows a further stage in the progress of the crankcase. The inner deck which carries the lower end of the cylinder liner is in place. The side plates and stiffening ribs have been added. The hand holes providing access to the connecting rod caps and the hand holes for inspecting the piston rings have been flanged in the side plate itself. In welded steel construction, there is a tendency to use thin sections because of the strength of the material. It is necessary to guard against unsupported areas of any magnitude in thin material when the mechanism is one which may set such areas in resonant vibration. The flued hand holes stiffen the thin plates admirably against this phenomenon. Fig. 10 shows the main bearing caps and oil pan. The main bearing girders are flame-cut from 4-in. steel plate. The oil pan was constructed as shown to provide a tie for the bottom legs of the main frame members. Fig. 11 shows the completed crankcase as it left the weld shop. This shows the crankcase mounted on

the oil pan to illustrate the manner in which the oil pan forms the bottom tie for the complete case.

Built in the high-strength, welding quality alloy steel,



Fig. 11—The completed crankcase and oil pan

this crankcase has a weight of about 2.6 lb. per horsepower. The entire engine weighs less than 10 lb. per horsepower running on the test block. Calculated from

the indicator card, each weld in this structure is subjected to an impact load of 38,000 lb. occurring twelve times each second. Referring to Fig. 1, the recently completed 300-hour full load run indicates that the frame has been subjected to a number of cycles of stress far beyond that necessary to establish the fact that the stress concentrations which undoubtedly exist in the frame are not large enough to raise the average stress above the endurance limit for the alloy steel from which the frame is made.

Welded steel crankcases of the types discussed enable the engine builder to offer to the user of mobile prime movers a light-weight, highly efficient and powerful unit, embodying all the advantages of the Diesel principle. Winton Engine Corporation, Cleveland, Ohio, with which it has been a privilege to work in this development, can offer today an engine-generator unit supplying 750 kw. of electrical energy which, including all auxiliaries, will weigh 30 lb. per hp. Railroad vision has enabled immediate application of this notable prime mover to main-line service. Under construction today is a welded steel engine structure which will be used in the power unit of the Union Pacific System's 110-mile per hour high speed passenger train. The Chicago, Burlington & Quincy's high speed passenger train will have, as its motive power, a 600-hp. Diesel engine of welded-steel construction.

Ratios of Modern Locomotives*

AT the 1932 annual meeting of the American Society of Mechanical Engineers A. I. Lipetz, consulting engineer, American Locomotive Company, presented at a session of the Railroad Division a paper on Horsepower and Tractive Force of Steam Locomotives (Locomotive Ratios). The author reviewed the work of Cole and others and checked their calculations against available test-plant and road-test data and developed constants for a new and easily applied method based on boiler evaporation and a factor depending on the number of revolutions of the driving wheels for use in connection with modern locomotives. An abstract of Mr. Lipetz' paper appeared in two parts in the March and April, 1933, issues of the *Railway Mechanical Engineer*. In view of the wide interest in this subject this article embraces a presentation of the abstracts of several discussions of the original paper together with an abstract of the author's closure in which many of the questions raised are replied to or answered.

Discussion

R. Eksergian (Engineering Department, E. I. du Pont de Nemours, Inc., Wilmington, Del.)—The author has pointed out the many difficulties in predicting accurately locomotive tractive force and horsepower characteristics, such as on the cylinder side of estimating and allowing for cylinder condensation and wiredrawing against speed, and on the boiler side the difficulties of estimating evaporation and likewise its variation with speed. His recommended method for the calculation of horsepower and

* Mr. Lipetz' paper "Horsepower and Tractive Effort of Steam Locomotives (Locomotive Ratios)," the several discussions and the author's closure appeared in full in the Transactions of the American Society of Mechanical Engineers, Railroad Division, Vol. 55, No. 9, Paper RR-55-2, pages 5 to 42 inclusive. The abstract presented here does not include the discussion contributed by H. S. Vincent, formerly chief consulting engineer, Franklin Railway Supply Co., nor that part of the author's closure relating thereto. The methods proposed by Mr. Vincent in his discussion will be the subject of an article which will appear in an early issue.

A summary of questions raised in connection with A. I. Lipetz' revised methods of easily applied coefficients for use with modern locomotives and the author's comments and replies

tractive force against speed is unquestionably rational and probably the best approximation in a preliminary analysis. For estimating the evaporation the Cole method has been retained, with a correction coefficient as a function of the speed.

In the application of the author's method we are immediately confronted with allowances that must be made for variations in boiler proportions and for different types of locomotives. These variations become sufficient to question the need of the Cole evaporation figure. This does not mean that the data supplied by Cole on evaporative yields for firebox and particularly for tubes of different lengths are not of extreme value in aiding in the calculations of the correct evaporation of a boiler, but such data became modified, with large grates, combustion chambers, etc., so that the data are perhaps antiquated except for a guide in a first approximation to modern power. The author himself has seen the necessity of this in his correction coefficient β .

The author has pointed out that the analytical method of estimating performance becomes extremely involved due to allowance for cylinder cooling, wiredrawing, etc., and on the boiler draft considerations, and the effect of grate, firebox, and other proportions on the evaporative yield.

George W. Armstrong (Consulting Mechanical Engineer, Ridgewood, N. J.)—The Pennsylvania test-plant experience for the locomotives used by the author represents boiler output at the time deemed capacity, with front-end design generally superior to most in use at that time. Subsequent improvements in front-end design have given much greater maximum capacity output. This naturally affects the engine or tractive-force

output of the locomotive, and developments for improvement in draft conditions and back-pressure reduction have in more than one instance resulted in 200 to 250 hp. increased output, due to greater boiler capacity. The great value of front-end improvement lies in the ability to support more efficiently high combustion rates, with consequent increase in available steam for engine output.

Evaporations as high as 10 lb. of water per sq. ft. of equivalent heating surface have been attained in road operation. On such a basis the New York Central J-1, cited by the author, should be capable of delivering around 78,000 lb. of steam per hour, instead of the 54,600 lb. which would materially influence tractive force and horsepower output. Experience with improved draft appliances on locomotives with boiler characteristics similar to this one indicates that this expectation is not unreasonable. The author has recognized this to some degree by placing "the peak point only 20 percent above the Cole figure."

W. F. Kiesel, Jr. (Mechanical Engineer, Pennsylvania)—The stated object of the paper is to establish a method of figures for calculation of indicated tractive-force as a function of speed. Throughout the paper references are made to the difficulties of establishing accurate formulas applicable to various types and variations of locomotives and detail equipment, establishing the need of adopting empirical data.

The author points out that Cole's ratios are no longer applicable to modern locomotives and submits his method of corrections necessary to make the Cole formulas more closely conform to modern power results.

The question of first importance is "How much steam can any given locomotive make available for use in the cylinders?" The author is rather vague on this point. He calls attention to boiler tractive force as distinguished from rated tractive force. The latter is dependent on boiler pressure and proportions of cylinders and drivers, and its calculation has been standardized by a simple formula. The designer is mainly interested in maximum boiler tractive force, which is dependent on maximum evaporation possibilities of the boiler. Conventional fire-tube boilers, with staybolted firebox, vary little in important proportions.

It is not far wrong to assume that the evaporation per square foot of combustion-space heating surface, compared with that of the flues and superheater (with flue sheets spaced about 20 ft. apart) is 6 to 1. Assuming that equivalent heating surface is the sum of superheater, flue, and six times the combustion-space heating surfaces (steam and water side), it has been developed from tests that the exaporation limit to date is closely $11\frac{1}{2}$ lb. per hour per sq. ft. of equivalent heating surface, which permits the empirical assumption that the steam available for use in cylinders may be as high as 10 lb. per hour for each sq. ft. of equivalent heating surface, for the whole range of boiler tractive force. When test results of a locomotive fall materially short of this it is advisable to make an investigation to determine reasons for the shortage.

The second phase of this problem is to determine the results in cylinder tractive force of the use of various amounts of steam in the cylinders up to the available limit. The author determines drawbar horsepower, but it would seem preferable to find the cylinder tractive force and subtract engine and tender resistance, the result being drawbar pull at rear of tender. Piston speed, or crank speed, suggested in the paper, can be used, but the writer prefers to use speed V in miles per hour, because that value is more generally used. He also prefers to determine cylinder tractive force T which can readily be transformed to indicate horsepower, if that figure is desired.

Assume:

Initial pressure $P = 10$ lb. less than boiler pressure

Engine constant $C = d^2 S/D$

Steam constant $M = 3W/110w$

d = cylinder diameter, in.

S = piston stroke, in.

D = driver diameter, in.

W = amount of steam used, per hr.

w = average weight of steam per cu. ft. at 100 deg. superheat and pressure P

Since modern locomotives, with few exceptions, use boiler pressures between 200 and 300 lb. per sq. in., the steam constant M may be written $M = xW$, the values of x being

Boiler pressure.....	200	225	250	275	300
Coefficient x	0.0716	0.0643	0.0571	0.0532	0.0493

Having determined P , C and M , the formula for tractive force becomes

$$T = \frac{2PM}{(M/C + V)}$$

The writer submits that this formula in use for the last 20 years, though to a certain extent empirical, is based on a rational

theory, gives fairly close results and permits deriving more information to determine preferential locomotive designs with less effort than by the use of modified Cole ratios.

Capacity versus Maximum Performance

G. T. Wilson (General Equipment Inspector, Motive Power, New York Central Lines, New York).—The writer thoroughly appreciates the fact that the results as obtained are subject to a factor of correction where the performance of the locomotive to which it is applied varies to an appreciable extent from the average results upon which the method of calculation is based.

The application of this boiler-performance calculating method to two of the most modern types of New York Central locomotives—the J-1, 4-6-4, and L-2, 4-8-2—indicates that the results as shown for tractive force and indicated horsepower in respect to speed are not representative of capacity rating for these locomotives as shown from dynamometer road tests.

It is the practice of the New York Central to rate a locomotive on capacity test results represented by the drawbar pull-speed curve for the respective locomotive or class. The capacity test results represent the maximum sustained drawbar pull and horsepower for all speeds for the respective class of locomotive as governed by the existing boiler ratios, drafting arrangement, valve setting, and cylinder characteristics.

For the past 20 years the capacity results have been used for tonnage rating with success. In the last few years we have made it possible by means of a device applied to the locomotive to provide the engineman with a visible indication of cut-off correlated to speed so that with full-open throttle the engineman may select a cut-off to produce maximum drawbar pull for that incidental speed. The cut-off indication of this device is based upon the capacity tests results for that class of locomotive to which it is applied. The incidental cut-off in terms of speed corresponds to the cut-off used when maximum sustained capacity was developed during dynamometer road tests.

Experience has proved that we may duplicate in everyday performance the actual capacity test results by selection of the same incidental cut-off as used to develop the drawbar-pull-speed curve.

Based upon our observations from dynamometer tests and average everyday operation we do not believe that the results for tractive force and horsepower for a modern design of locomotive may be consistently based upon average performance tests as representative for the tractive force and power of the locomotive. We contend that the capacity performance of a locomotive is representative of the true characteristics of the boiler and engine because such results eliminate the human variable, common in performance results, and show the true performance as governed by the design of the boiler, feedwater heater, superheater, drafting arrangement, and steam distribution to cylinders.

A. Giesl-Gieslingen (New York).—The writer would like to comment on Mr. Wilson's remarks dealing with locomotive "capacity," versus "maximum performance." Certainly a railroad is interested in the utmost limit of capacity of a locomotive, since it is of importance on frequent occasions. However, this limit is subject to many influences, the most imponderable of which is probably the boiler capacity as it is governed by the accidental quality of the coal and the ability of the fireman. These latter influences are, of course, always felt, whether the engine is working light or hard, but for every locomotive there is a reasonable maximum of performance which can safely be developed, whoever may handle it and whatever conditions may be, and this is what the author primarily determines. The boiler is then called upon to work only at a conservative rate.

Determination of Horsepower

Ching Pong Pei (Champaign, Ill.)—It is correctly stated in the paper that no one formula can express the tractive force of all locomotives. It is equally difficult to express all the factors affecting the development of the tractive force of the locomotive under the varying operating conditions in any single, simple formula or equation. Such being the case, in the formulation of any one simple equation for the tractive force of all locomotives one is forced to make a choice in the selection of the more important items and the elimination of the lesser ones.

The author, in arriving at a basis upon which his suggested method of calculation is constructed, used the most direct method of first determining the horsepower output of the locomotive and then obtaining the tractive force from the well-known equation $P = (T \times V) - 375$ or $T = (P \times 375) / V$.

The horsepower output of the locomotive is to be determined by the direct method of dividing the total boiler evaporation by the steam consumption of the locomotive cylinders and the auxiliary devices. The relation between the horsepower and the tractive force of the locomotive as defined by the latter equation is mathematically exact. Hence the whole problem is reduced to the determination of horsepower which entails only

two factors—the total boiler evaporation and the total steam consumption.

The justification of correlating the boiler evaporation with the rotative speed of the locomotive, as expressed by the formula $E = \beta Ec$ is, as the writer sees it, premised on these assumptions:

1. The Cole evaporation figures E as derived from the performance of the locomotives of the pre-war period still hold good on modern locomotives.

2. The draft efficiency is uniform on all locomotives, being only a function of the amount of steam passing through the exhaust nozzle, which implies that the same amount of steam is exhausted from the cylinders at a certain rotative speed of all locomotives.

3. The firing rate in the firebox and the boiler efficiency are each only a function of the draft produced in the front end.

There is no way to prove or disprove the validity of the first assumption, since no mention has ever been made about the firing rate in connection with the Cole evaporation figures. Likewise, the author avoided specifically stating the firing rate or the boiler efficiency at which the evaporation figures were derived. There is no doubt that at some firing rate an evaporation figure as shown by the Cole figure can be obtained. It is equally true at some other firing rates that the evaporation rate can be either higher or lower than the Cole figures. In the derivation of boiler-evaporation figures the author stated that the Cole evaporation figures still hold good on modern locomotives. Whatever significance may be attached to the Cole evaporation figures, it is clear from the foregoing statement, according to the author, that there has been no material improvement in the locomotive boiler performance, with the exception of the increase in boiler capacity made possible by the addition of feedwater heater, during the last 15 or 20 years. Does this not offer a challenge to the railroad mechanical department in general and the locomotive designer in particular?

It is rather difficult to subscribe to the second assumption in that the same amount of steam is always exhausted from the cylinders at a certain rotative speed of the locomotive. This would be true only when the locomotive is operated with a definite and exacting relationship between the cut-off and the rotative speed. In a general way, the locomotive is operated with longer cut-offs at low speed and with shorter cut-offs at high speeds, and this is as far as the relation between the cut-off and the rotative speed goes. Hence, this assumption cannot hold true for any one locomotive, let alone for all locomotives.

The steam consumption of the locomotive cylinders is naturally mainly a function of the percentage of cut-off at which the engine is operated. It is also a function of the pressure and the temperature of the steam, both at the steam chest and at the point of cut-off. Test results of locomotives on testing plants seem to indicate that there is always a narrow range of cut-offs to be operated with a certain rotative speed, the combination of which results in the minimum steam consumption, other conditions remaining unchanged. On the other hand, if we were interested only in the maximum capacity of the locomotive it may be operated with a much longer cut-off than that at which the minimum steam consumption is obtained, limited only by the capacity of the boiler to supply steam. At any stated boiler capacity, which is mainly a function of the amount of fuel burned, the locomotive can be operated with a number of different cut-offs at one rotative speed, in which case the locomotive would develop different values of tractive force, according to the cut-off, at the same rotative speed. It is, therefore, not sufficient merely to correlate the tractive force and speed, as represented by the ordinary tractive-force-speed curves, without specifying the manner in which the particular tractive force figure is obtained.

It is not possible to express the tractive force of a locomotive by any single, simple formula, however desirable it may be, and it is also almost meaningless merely to state that the locomotive would develop so many pounds of tractive force at a certain speed without specific qualifications. In view of these difficulties, would it not be more logical to present the locomotive tractive-force data in the form of a series of tractive-force-speed curves, each one representing a certain firing rate and each point on a curve representing the tractive force obtained with the most suitable cut-off at the corresponding rotative speed?

The Question of Superheat

John E. Muhlfeld (Consulting Engineer, New York).—Concerning the author's proposed modernization of the Cole ratios for the purpose of meeting present-day requirements, the writer questions the differentiation based on the so-called types E and A superheaters. In his conclusion the author states: "The object of this paper is to suggest a simple method for figuring horsepower and tractive force for modern locomotives. To this class belong locomotives with type E superheaters, feedwater heaters and valve motions with about $8\frac{1}{2}$ in. of valve travel.

This presupposes that the superheater heating surface assures sufficient superheat, which in locomotives with the type E superheater is about 250 deg. F. * * * For locomotives of older design, with type A superheaters, new constants could be worked out similar to those given in the paper, but it is suggested that for these latter locomotives the Cole formula should be used."

Any number of modern steam locomotives equipped with type E superheaters, with from 200 to 250 lb. boiler pressure, are not averaging superheated steam of over 600 deg. F., or much over 200 deg. of superheat, when working steam. This performance can be duplicated by many of the older locomotives originally constructed without superheaters, but which since have been equipped with type A superheaters, and, with 200 lb. boiler pressure, can raise total steam temperatures of from 700 to 750 deg., and average from 600 to 650 deg. F., thereby producing as high as 350 deg. superheat as a maximum and from 200 to 250 deg. F. as an average.

The particular feature of the type E superheater has been its increased superheating surface which reflects favorably on the boiler capacity and, in combination with the higher velocity draft, has been set up as the principal advantage over the type A. However, as compared with the type A the type E has many operating disadvantages owing to the overheating, swelling and burning out of the torpedo type of forged return bend; the more restricted gas area through the superheater flues; the stopping up with cinders, ash, soot and other foreign matter of superheater flues resulting in stuck units; the increased gas velocities through the superheater flues tending to cut out crown-sheet staybolt heads and the beads on the firebox end of the flues, and to a more rapid cutting action of the cinders against the return bends and the element necks, necessitating application of innumerable shields to these parts to prevent such action. All of these conditions mean increased maintenance troubles and expense and of operating inefficiencies and failures which do not obtain with the type A superheaters.

Summing the locomotive superheater situation, it is the writer's opinion that the author's method of calculating tractive force should be used on locomotives having 100 per cent or larger boilers, modern long-travel valve gear, and a sufficient degree of superheat, whether equipped with a type E or a type A superheater.

With respect to high superheat temperatures, it is questionable as to the practical advantage or economy in superheating steam to higher temperatures than what is required for minimum cylinder condensation, in view of the useful heat that will be exhausted to the atmosphere. To produce 70,000 lb. tractive force in a single-expansion-cylinder locomotive carrying 200 lb. pressure, with 63 in. driving wheels, would require the admission of live steam into two $28\frac{1}{2}$ in. diameter by 32 in. stroke high-pressure cylinders. At 250 lb. pressure the diameter of the cylinders would be about $23\frac{1}{4}$ in. If 500 lb. pressure is used in combination with single-expansion cylinders, it would only be necessary to put live steam into two 18 in. diameter by 32 in. cylinders, with 63 in. diameter driving wheels, in order to develop 70,000 lb. tractive force and, in which case, with the conventional amount of superheat, from 75 to 100 deg. of superheat would be wasted in the exhaust steam.

By increasing the conventional 200 to 250 lb. boiler pressure, assuming 200 deg. F. superheat as a constant, regardless of the pressure, it has been shown that only 28.5 additional B.t.u. are required to produce steam at 500 lb. as compared with 200 lb.

The author has contributed valuable information concerning calculations for designing modern steam locomotives which will be of great benefit to railroad engineers and locomotive builders. At the same time practical operating and maintenance factors should not be overlooked. These can only be determined by dynamometer-car tests and the data can be scientifically utilized to develop empirical formulas.

Feedwater Heaters and Front Ends

Thos. C. McBride (Consulting Engineer, Railroad Department, Worthington Pump & Machinery Company).—The system of locomotive ratios proposed by the author considers the feedwater heater and its effect in increasing the maximum evaporation obtainable from the boiler. The statement of this increase introduces a new and important ratio. A large amount of information that has been collected over a number of years on locomotives without heaters is made available in the consideration of present-day locomotives with heaters by the application of this new ratio. Careful consideration and accurate statement of this new ratio are, therefore, important.

The author reaches the conclusion that the Cole evaporation figures still hold good for boilers on modern locomotives without feedwater heaters, but when locomotives are equipped with feedwater heaters, the boilers generate 7 per cent more steam. In contrast with this conclusion, feedwater temperatures obtained from feedwater heaters on locomotives operating at the maximum rates of the Cole ratios indicate an average of approxi-

mately 15 per cent additional heat to the boiler through the heater, and this additional heat can get out of the boiler only through a like increase in evaporation. The difference between these two figures is too great to neglect, especially in developing a system of locomotive ratios.

The author has taken great pains to collect and carefully apply a mass of data obtained partly from road trials of locomotives, but road trials necessarily involve large "probable errors". A few temperature readings taken simultaneously while the locomotive is known to be working at the desired maximum make it possible to calculate the extra heat going to the boiler through the heater with a probable error of but a few per cent. It is necessary only to read the temperatures of the water entering and leaving the heater and the steam pressure and superheat at the moment the indicator card or other check is made on the capacity of the locomotive. The process can be repeated every few minutes and more exact information gathered in an hour than could be obtained from a month of road trials.

The writer has shown that (assuming 200 lb. boiler pressure, 150 deg. F. superheat, and 215 deg. F. feedwater temperature obtained, with alternate assumptions of water at 40 deg. F. from the tender to represent winter and 70 deg. F. to represent summer conditions) the additional heat supplied to the boiler through the heater is 13.6 and 11.1 per cent, respectively. That is, presuming exactly the same amount of fuel burned and exactly the same amount of heat transmitted to the water and steam in the boiler, with the consequent same efficiency of the boiler, the feedwater heater increases the heat to the boiler, and, consequently, the evaporation from the boiler by 13.6 and 11.1 per cent respectively, under the conditions assumed.

These assumed conditions were considered representative of usual road operation in 1920. When locomotives are operated at the maximum contemplated in the ratios, much higher feedwater temperatures are obtained, generally 240 deg. F. and frequently 250 deg. F.

If the conditions assumed in the paper of 1920 are again used for the sake of comparison, but with a feedwater temperature of 240 deg. F., each pound of water will carry into the boiler from the heater 240-40, or 200 B.t.u., and will require 1284.6 +32-240, or 1076.6 B.t.u. from the fire for generation into steam. The heater increases the heat from the fire by 200/1076.6, or 18.6 per cent. But of the total of 118.6, 2 per cent, or 2.4, is required to operate the feed pump, leaving 118.6-2.4, or 16.2 per cent net increase in heat because of the heater. Similarly, with the alternate assumption of water at 70 deg. F. from the tender, each pound of water carries into the boiler 240-70, or 170 B.t.u., and requires from the fire the same 1,076.6 B.t.u. The addition to the heat from the fire by the heater is 170/-1,076.6, or 15.8 per cent. Of the total of 115.8, the feed pump requires 2 per cent, or 2.3, for its operation, leaving 113.5, or a net of 13.5 per cent additional heat to the boiler through the heater.

The average of 16.2 and 13.5 is 14.8, or practically 15 per cent. It is thought that this figure, or some figure close to it, depending on the conditions assumed to represent average present-day locomotive operating conditions, should be adopted for the ratios, instead of the 7 per cent obtained from road trials.

Summing up, the writer believes we are bound to recognize the differential of 15 per cent or thereabout increased evaporation in favor of the boiler with heater, in view of the direct and accurate evidence of the temperatures obtained. It will then be necessary to modify Fig. 3 and Table 1, spreading the "evaporation coefficient" to a differential of 15 per cent at high and medium r.p.m. But over all this looms the condition of the fire, new or old, demanding at least recognition.

H. B. Oatley (Vice-President in Charge of Engineering, Superheater Company)—The Cole ratios, which have been considered as a standard for more than a generation, were, and still are, of great value and have had widespread use both by railroads and locomotive builders. The marked change in value of factors entering into the design of locomotives during this time has made it necessary that extensions to and modifications of the Cole ratios be made so that there could be comparisons between different types of locomotives and the effect of improvements be evaluated.

The paper offers methods and formulas which, while somewhat more complicated than have been used hitherto, are more easily applied and far less complex than methods used abroad. Any set of equations must, of necessity, be considered approximate within recognized limits. The interrelation between combustion, heat absorption, and conversion to external work is so intimate that the design of the various parts introduces a large number of variables that cannot be accurately determined.

W. A. Pownall (Wabash, Decatur, Ill.)—Fig. 12 shows the Timken engine with a performance curve much higher than the Cole or the proposed method. The author states that this may be due to a good quality of coal, but it is believed that this exceptional performance at high speeds is due to the type of front

end used on the Timken locomotive. The exhaust nozzle is a six-ported star-shaped design, of larger area than the customary round nozzle tip, but which at the same time produces a steam jet with greater entraining power due to its greater periphery. The usual draft plates and deflector plates in the front end are dispensed with, and in their place is an inside stack with flare, the lower edge of which is about 12 in. above the bottom of the smoke arch, and the netting consists of a straight cylinder extending from the lower edge of the stack to the bottom of the smoke arch. The stack itself is somewhat larger than the conventional stack. This arrangement produces very strong draft, and with less back pressure on the cylinders and because of the strong draft, grates with reduced air opening have to be used.

The Wabash has equipped a 4-8-2 type locomotive with similar front-end arrangement, and has obtained as high as 4,900 i.h.p. at a speed of 55 m.p.h. The maximum cylinder horsepower by the Cole method would be 3,215, and by the Lipetz method 3,237. This engine in actual service evaporated at times water at the rate of about 80,000 lb. per hour, whereas the maximum evaporation from the Cole method is figured with coal burned at the rate of 120 lb. per sq. ft. of grate area per hour, whereas this rate was very much exceeded during the actual performance of the engine in question. Tests of Pennsylvania engines equipped with this front-end arrangement (this design of front end was developed on the Pennsylvania) have shown similar evaporative rates and increased horsepower. The high horsepower developed is undoubtedly contributed to by a lower water rate due to reduced back pressure, and the writer would point out this low water rate on the Timken engine as indicated in Figs. 6 and 7 of the paper.

Piston Speed and Speed Factors

L. K. Sillcox (Vice-President, New York Air Brake Co.)—The variation of speed factors with the piston speed for superheated locomotives are shown in Table 15, as derived by Cole in March, 1910, at which time it was found that the average maximum horsepower was reached at 1,000 ft. piston speed per min. and remained constant at higher speeds. Recent tests with locomotives indicate a distinct rise in percentage of about 10 per cent beyond the figures shown from 1,000 ft. piston speed and up, and herein lies the advantage which is observed in the locomotives constructed in 1933 compared with 1910, when sustained capacity at speed is to be judged.

TABLE 15

Piston speed, ft. per min.	Speed factor	Modified speed factor	
		1910 (Cole) Modified factor =	1933 (test) Modified factor =
0-250	1.000	0.85	0.93
300	0.955	0.85	0.930
500	0.770	0.812	0.888
700	0.605	0.655	0.716
1,000	0.445	0.514	0.562
1,200	0.371	0.378	0.414
1,400	0.318	0.315	0.345
1,600	0.278	0.270	0.296
		0.236	0.258

One can readily subscribe to the accuracy of the author's method of approach to the problem of predetermining locomotive characteristics. So long as authentic data are available for guidance in estimating the probable relation between the expected and Cole evaporation, no marked discrepancies should be introduced in the results. Much of the familiar Cole formula is retained. In fact, the effect of the addition of a superheater might be similarly expressed by constructing a curve to indicate the relative performance of a locomotive so equipped with respect to one employing saturated steam. Conversely, the Cole constants may be extended to include factors which take into account the benefits derived by the preheating of feedwater, by the partial eliminating of throttling losses effected by long-travel valve gears, and by any improvement which serves to increase the availability of the energy contained in the fuel fired. In like manner the Cole speed factors may, by the application of proper modifications, be rendered applicable to any change in the relation between boiler and cylinder capacity, anticipating probable change in the shape of the horsepower curve.

Whether the author's method is adopted or the Cole analysis modernized, the results should bear marked similarity. Locomotives must be grouped, in either case, on a basis of relative proportions and the extent to which the latest refinements are incorporated in their design. Both are dependent upon the accumulation of adequate test data for the degree of accuracy experienced. While simplification of calculation is claimed for the author's analysis, familiarity, confidence and universal acceptance recommend retaining the Cole method in principle. The many tests already cataloged in their agreement with calculated performance using the Cole equations suggest the desirability of continuing the practice so well established in order that a common

basis of comparison of the old and the new may be preserved. The introduction of any method which represents the departure from an accepted standard will likely be strenuously opposed so long as the familiar process can be revised to produce dependable results.

S. S. Riegel, mechanical engineer, D. L. & W., in his discussion, stated that horsepower and tractive-force curves worked out for modern fast-freight locomotives on that road using Mr. Lipetz' simplified methods and the Cole methods were in harmony with the methods suggested by Mr. Lipetz and that they were satisfied with the correctness of the deductions as stated in the paper.

Author's Closure

At the beginning of the paper it was pointed out that there are two possible methods of evaluating the horsepower and tractive effort of a locomotive. In the first method, by using mathematical analysis, it would be quite possible to follow through the various processes taking place in the cylinders for a certain amount of steam of known quality (pressure and temperature). This analysis would be very intricate, as a great number of complex factors has to be taken into consideration. Furthermore, as such analysis would represent a consecutive chain of premises and sequences, the final result would depend upon the validity of each individual premise; and there would be no assurance that the method would lead to reliable results.

In order to eliminate all these difficulties and offer a practical quick method for evaluating the horsepower of a locomotive, it was suggested in the paper to apply an empirical method, by which the power is figured on the basis of the total evaporation of the locomotive boiler and the approximate steam rate per horsepower-hour at various speeds. Thus only two variable factors are introduced in the calculation instead of a multitude of factors, and in addition both factors are such that they can be figured fairly accurately. The evaporation of a locomotive boiler is more or less known. It has been measured and evaluated hundreds of times, and the Cole figures seem to represent very closely the amount of steam which can be generated by a locomotive under normal conditions without excessively forcing the boiler. As to the steam rate, it is also known that a well-proportioned and properly designed locomotive has fairly definite limits for steam consumption per horsepower-hour for various conditions of work. It would seem, therefore, that a method by which these two variables are tied together should give more accurate results than complex formulas.

Second, it must be borne in mind that the objective of the method is not to predict with accuracy the power-and-tractive-effort curve of any locomotive of any design. As Mr. G. W. Armstrong puts it rightly, the object is to provide a "comparator" for evaluating locomotives of known designs. One or another locomotive having an unusually large superheater, or firebox, or combustion chamber, or cylinders, or a special draft arrangement, or some other novelties which are being tried out from time to time, can not be evaluated by the suggested method. Only the average well-proportioned and properly designed locomotive can be served by this method with a reasonable degree of accuracy, and the locomotive with the enumerated or other improvements has to be evaluated by comparing its performance with the predictions of the formula.

Third, as it has been already pointed out in the paper, there are great many kinds of tractive effort which are of interest and are being considered in different cases. It is therefore always possible to find fault with one or the other method of figuring tractive efforts and to point out that some tests show higher or lower figures than those obtained by the method. Tractive effort is not a definite thing, and it is not the *maximum* tractive effort which is being sought. It has been explained in the paper that the method permits to determine the *performance* curve which is usually obtained under normal conditions of work; and I should like to add here—and with a reasonable degree of efficiency. This will be explained later.

As regards the paper itself (not the method), it should be remembered that the theories and various statements made in the paper which may be open to criticism have no influence on the method in the final recommended form. Neither the theory of the variation of evaporation with speed, nor the evaluation of coefficient β , nor the actual steam rate as obtained from tests, has any bearing on the final results. These theories and statements had been brought out in order to make clearer the way by which the method was developed. After formulas [12] and [13] and Table 7 had been established, they were checked for all modern locomotives for which test data were available, and the results were shown in Figs. 10 to 15 of the paper. The preliminary theories and statements were thus no more than stepping stones, which can be removed after the final formulas and empirical constants had been established and verified, and the criticism of these theories, by purely theoretical considerations, cannot undermine the method itself.

Mr. Kiesel does not think it necessary to figure the evaporation of a locomotive separately for various parts of the boiler as established by Mr. Cole. He recommends to figure the evaporation on the basis of *equivalent* heating surface, assuming the equivalent heating surface equal to the sum of superheater, flue, and six times the combustion-space heating surfaces, and the average evaporation equal to $11\frac{1}{2}$ lb. per hr. per sq. ft. of so-defined equivalent heating surface. The firebox heating surface seems to be a part of the combustion-space heating surface. This designation for the equivalent heating surface is based on an empirical law found by Mr. Kiesel—namely, that the evaporation of a combustion-space heating surface is six times as high as that of the flues and superheater, if the length of the flues is about 20 ft. Mr. Kiesel further assumes that 10 lb. per sq. ft. of equivalent heating surface represents steam available for use in cylinders.

I do not think that such a rough method of calculating the evaporation would satisfy us, with all the knowledge that we have now, especially the inclusion of superheating surface into the total surface for figuring evaporation. This can be considered only as a necessary correction for the increase of power due to superheating, although one correction for the effect of superheating is already included in the Kiesel formula by referring w to pressure P with 100 deg. superheat. Moreover, such a method offers no advantages over the more accurate Cole formula, which has been proved to be satisfactory by many years of use, and to hold good even now for modern locomotives, as it has been shown in the paper and corroborated by many discussers. A simple calculation of evaporation for any of the locomotives cited in the paper, for which we have data, will show that Mr. Kiesel's empirical rule gives highly exaggerated figures. They are not evaporation figures any more, but simply values of W to be substituted in Mr. Kiesel's formula, which thus becomes a purely empirical formula. Mr. Kiesel concedes this, but is of the opinion that the formula is based on a rational theory. This may be true, but the rationality of it is more than offset by the omission of a great number of important factors which cannot be expressed by mathematical formulas, and therefore must be compensated by such figures as evaporation of a superheating surface and others.

The author cannot agree with the statement that he is vague on the point of how much steam any given locomotive can make available for use in the cylinders. There is a definite formula in the paper for the amount of steam available for the cylinders—namely, $E(1-x)$, just preceding formula [6]. This is made use of in formulas [6] and [6-A]; evaporation E is explained and figured in the paper x is included in Figs. 5 and 6. Mr. Kiesel's statement that the author "determines drawbar horsepower" while he prefers "the cylinder tractive force" is evidently a misunderstanding, as the paper is about the indicated horsepower and tractive effort, while hardly mentioning the drawbar horsepower at all.

The question of *maximum* versus *performance* tractive force was discussed by Messrs. G. T. Wilson and A. Giesl-Gieslingen. The latter's discussion may be considered as a reply to Mr. Wilson, which makes a further reply unnecessary. The author will only add that he stated in the paper his reasons for working out a method by which the performance, and not the maximum horsepower and tractive-effort curves, would be plotted. It would not be desirable to develop a method by which only capacity curves, such as shown on Figs. 9 and 10, would be obtained. These two locomotives, both of the New York Central Railroad, and tested under similar conditions, give maximum capacity figures, which, according to Mr. Wilson, differ from those obtained by the author by 17 per cent in one case and 42 per cent in the other. Similar relation of discrepancy would be obtained if the Cole, or the Vincent, or the Kiesel formula were applied, although the figures might be different. No method would satisfy both capacity curves, and therefore these high power figures must be partly ascribed to local conditions, such as quality of fuel and method of operation, which may be different on different roads, and partly to the design of the different parts, which cannot be expressed by a formula. It would not be advisable to have a yardstick formula for comparison based on the capacity of the 4-6-4 J1 locomotive. These capacity curves every railroad has to find out for itself.

As to the value of capacity tests, it has been also pointed out in the paper that unless there is complete assurance that the capacity tests have been made without exceeding the sustained evaporation of the boiler, the capacity figures are likely to be exaggerated and cannot be taken as basis of locomotive performance.

Mr. Ching Pong Pei raises several interesting points. He seems to be somewhat puzzled that no reference has been made in the paper to the rate of firing.

As far as Mr. Cole's figures are concerned, the author is to blame for not having stated definitely that Mr. Cole was considering the rate of firing of 120 lb. per sq. ft. per hr. As the author made reference to Mr. Cole's publications and the Alco

Handbook, he did not think it necessary to repeat Mr. Cole's firing rate. Personally, he does not attach much significance to the rate of firing in the case of modern locomotives. When Mr. Cole devised his figures, the grate areas were comparatively small. Modern locomotives have much larger grate areas, and as stated in the paper "in well-designed locomotives the proportions are such that the two factors more or less balance," the two factors being the limitation of the amount of coal which can be burned on a certain grate and the amount of heat which can be absorbed by a certain heating surface. In modern locomotives the second is more often than the first the ruling limitation, and it is therefore permissible to consider the evaporation as determined by the heating surface, rather than by the grate area.

In view of the foregoing, smaller firing rates than what Mr. Cole figured on are now actually being used. In his paper the author was not interested in firing rates in view of the indefiniteness of the figures and also for the reason that they fluctuate too much. Moreover, they cannot serve as indications of forced or normal operation of a locomotive, as this depends upon the relative size of the grate. Therefore, the author would not be in favor of Mr. Pei's suggestion to plot a series of tractive-effort curves for various rates of firing. This would be a very indefinite basis for comparison, although it may be an interesting method of scientific investigation of locomotives of certain types.

The author already pointed out in the paper that, strictly speaking, tractive effort becomes a definite conception only when the conditions at which the tractive effort is produced are specified, as for instance the maximum tractive effort, the most economical tractive effort, the constant-evaporation tractive effort. Mr. Pei's suggestion is along these lines—he would have constant-firing-rate tractive efforts. Much more reliable conclusions can be drawn if these curves are plotted for different constant-evaporation rates. A still better way of comparing locomotives, at least for some purposes, would probably be on the basis of equal overall efficiencies.

However, the difficulty with all these methods, in which a system of curves is considered, is that during actual operation the locomotive is not burning a constant amount of coal per unit of grate area per hour, nor is it generating a constant amount of steam per unit of heating surface per hour, nor does it work at a constant efficiency. These factors are varying all the time, and in the opinion of the author, the higher rates of firing and evaporation are obtained at higher speeds. If anything, the locomotive is more likely to work at constant efficiency at certain modes of operation—performance, maximum performance, capacity. If a tractive-effort curve obtained from test performance, or capacity, be plotted over a chart consisting of a series of curves for different constant rates of firing or evaporation, probably it will be found that the actual tractive effort intersects all the other curves. If, therefore, a chart as suggested by Mr. Pei is presented to a railroad operator, as he recommends, it would be necessary to give him a table or chart, indicating the speeds at which the different rates are actually materialized. This would enable him to determine points, one on each of the curves, and plot the actual tractive-effort curve.

The author preferred, therefore, not to be bound by such purely theoretical considerations and to consider the curves which from actual tests are known to be obtainable in every day's service. These, called *performance curves*, can be plotted as shown in Fig. 16 of the paper for the New York Central 4-6-4 locomotive. These curves correspond to reasonable overall efficiencies (about 6 to 7 per cent) and to firing rates for modern locomotives up to 90 to 110 lb. per sq. ft. of grate area per hour, as can be figured out from the total evaporation (E), average evaporation of coal (7 lb. of water per 1 lb. of coal), and grate area of any of the foregoing examples.

The author is not in agreement with the second and third premises, quoted by Mr. Pei, as those on which the correlation between boiler evaporation and rotative speed of the locomotive is based. Neither of the two premises has ever been mentioned by the author; as a matter of fact, the meaning of the second is not clear to him. The correlation referred to is for him a matter of observation of innumerable locomotive tests and conclusions drawn from stationary tests. As it has been stated elsewhere, the ultimate recommendations of the method do not depend upon the correctness of the assumed correlation.

Mr. Muhlfeld takes issue with the author in considering the type "E" superheater as a part of the "modern locomotive," asserting that type "A" superheaters are able to give just as high superheats as the type "E." In this latter respect Mr. Muhlfeld is quite right. In his conclusion the author stated also that "this [the use of the Cole method for all locomotives with type 'A' superheaters] should not imply, however, that type 'A' superheaters can never develop the horsepower recommended by the new method. Locomotives are known that have given very high performance figures with type 'A' superheater on good coal."

It is obvious that the locomotive power depends upon the proper superheat, and that if type "A" superheater is so dimen-

sioned that it can insure as high a temperature as type "E" superheater, the performance of a locomotive equipped with this type of superheater should be just as good as that with the type "E." It has also been stated by the author that it would be better to refer the performances not to the type of the superheater, but to the temperature of superheat. However, it was pointed out that "it was not thought advisable to give constants for various superheats for the reason that before a locomotive is tested, its superheat is not known, and therefore these constants would not be helpful in calculating the horsepower of a locomotive beforehand." It was also mentioned that it would be more logical to base such constants on the relation of the superheating surface to the evaporative heating surface. The author tried to find a law for such a dependence, but so far such comparisons did not give conclusive results.

There is one important thing which justifies considering the type "E" superheater a feature of the "modern locomotive," especially American; namely, it is difficult, even impossible, to build a type "A" superheater with a sufficiently large heating surface in a large locomotive boiler, while the type "E" superheater permits doing it. The ratio of the superheating surface to the evaporative heating surface in the largest type "A" superheater is only about 0.32, whereas it is possible to design a type "E" superheater with a ratio of 0.45. The majority of locomotives with type "E" superheaters has a ratio of 0.41 to 0.42. Mr. Muhlfeld cites certain examples in favor of the type "A" superheater which are small locomotives. Likewise, all European locomotives, which have mostly type "A" superheaters, are of comparatively small size. The difficulty occurs only when locomotive heating surfaces reach 4000 to 4500 sq. ft. for which the type "E" superheater seems to be indispensable.

Mr. McBride is of the opinion that the increase in evaporation capacity of a boiler equipped with feedwater heater, found by the author to be 7 per cent, is underestimated, and that 15 per cent would be a more correct figure. He may be right in that the extreme 15 per cent figure calculated by Mr. McBride on the basis of heat saving is correct when everything is in first-class condition and the locomotive is working at the peak of its capacity. For average conditions 7 per cent is a more acceptable figure, although it may seem somewhat conservative.

Mr. McBride does not believe that road tests for which the author's figures were taken can be sufficiently accurate. But tests made on the Pennsylvania testing plant with 11s locomotive equipped with a feedwater heater of the open type showed a saving in heat fluctuating between 4.7 and 10.2 per cent, of which 7.45 per cent is the average. Therefore, when the evaporation figures found by the author were about 7 per cent above the Cole evaporation figure, he thought that the most simple way of introducing the feedwater heater into the ratios would be leaving the Cole figure unchanged and adding 7 per cent to that for locomotives equipped with feedwater heaters—this being in good agreement with stationary test results. The author believes that 7 per cent is a fair figure for average operating conditions, for the performance curve on the basis of available experimental data.

I do not quite agree with Mr. Oatley when he says that "the new method offers formulas somewhat more complicated than have been used hitherto." This would be true if we exclude the figure of boiler evaporation from the Cole method. However, ordinarily the Cole method requires the figuring of the boiler percentage, and in this case the knowledge of the boiler evaporation is also required.

Mr. Armstrong is right in calling attention to the discrepancies which might be found if the curves according to my method are compared with test results of locomotives equipped with improved drafting arrangements. Mr. Pownall also called attention to this fact, giving figures obtained from the Timken locomotive, which gave exceptional results at high speeds.

Table 15 is given by Mr. Silcox in which new factors are suggested, differing from Cole figures by 9.2 to 9.5 per cent. They are marked "test"; it is claimed that they are based on recent tests and that the difference between them and Cole figures represents the advantage of the locomotive "constructed in 1933 as compared with 1910," when Mr. Cole devised his method.

The author is not familiar with the tests to which Mr. Silcox refers, and as no particulars of the tests or any data are given, the author is not in a position to dispute or confirm the suggestion of raising the Cole factors by 9.2 to 9.5 per cent for all speeds. He may only state this—when the need for a revision of Cole factors became apparent, the first thought was to increase Cole factors in a certain proportion. This was tried, but it was impossible to establish a uniform rate for all cases. This can be easily concluded from Figs. 9 to 14, in which the Cole curves, together with test performance curves, are shown. At low speeds (50 to 80, or 110 r.p.m.; piston speeds approximately 250 to 400, or 440 r.p.m.) they were found in some cases above performance curves, and their further increase was not desirable (Figs. 9, 11, and 12), while in others the whole curve lay

below the performance curve (Fig. 10), and still in others the curves touched each other at 50 r.p.m. The reason for this was evident—these locomotives had different boiler percentages. The next thing the author tried was to change the Cole curves in relation to the boiler percentages. He got more consistent results, but then it occurred to him that by doing so he eliminated the Cole values altogether, because the cylinder horsepower was thus introduced twice, in the numerator and the denominator, and these two values canceled each other, leaving only a value proportional to the evaporation. Then the natural thing to do was to consider the evaporation only—what he did in his method.

The author explained in his paper the reasons for preferring to figure the locomotive characteristics on the basis of boiler dimensions rather than cylinder sizes. It is not necessary to repeat here the arguments, but it suffices to say that if we agree to limit ourselves to locomotives of a certain period and type, any essential part of a well-proportioned locomotive may be chosen as a yardstick for measuring its power. Superheating surface, weight, even length of a locomotive, could be selected for that purpose, and it would be found that the ratios of power to each of the enumerated dimensions fluctuate very little in modern locomotives. Nobody would seriously consider measuring the power of a locomotive by its length, but in the author's opinion, there is more justification in measuring it by the heating surface of the superheater (of a certain type) than by the size of cylinders. In Table 22 horsepower of all locomotives cited in the paper are referred to the product $pb \times A$ (boiler pressure times piston area), which represents the main factor in figuring the power of a locomotive according to Cole and also to Mr. Sillcox. The only difference between them is that in Cole's formula these products are multiplied by certain factors, while Mr. Sillcox would increase these factors by 9.2 to 9.5 per cent.

The ratios of column 3 of Table 22 vary from 0.0230 to 0.0294, or 28 per cent. In the same table Cole evaporation figures Ea (not counting the increase due to feedwater heaters) and the ratios of power to these figures are also given for comparison.

Table 22

Locomotive	Maximum ihp (performance) 1	$pb \times A$ 2	Ratio of col. 1 to col. 2 3	Total evapo- ration, lb. per hr. 4	Ratio of col. 1 to col. 4 5
New York Central, 4-6-4	3250	110,447	0.0294	54,662	0.0594
New York Central, 4-8-2	3240	128,825	0.0252	59,514	0.0544
Lehigh Valley, 5100....	3750	143,139	0.0262	70,530	0.0531
Lehigh Valley, 5200....	3800	135,587	0.0271	71,694	0.0530
Timken, 1111	3650	143,139	0.0255	67,370	0.0542
Boston & Albany, A-1..	3400	147,780	0.0230	62,958	0.0541

They fluctuate only 12.1 per cent—much less than ratios in column 3.

The dependence of Cole's method upon cylinder sizes will always make the correctness of his figures a function of boiler percentages. For switching and limited cut-off locomotives with comparatively small boilers and large cylinders, any revised Cole figures will be exaggerated, while for high-speed locomotives with small cylinders, such as in the New York Central 4-6-4 engines, the opposite will be the case. At the same time, the real source of power, the boiler, will not be taken into account. Mr. Sillcox's reasons for his recommendation to preserve the

Cole method and modernize his figures are "familiarity, confidence, and universal acceptance" of the method. In the author's opinion, if it is agreed that the Cole method is not based on correct premises, the enumerated advantages of the Cole method are of little importance. As the art progresses, Cole figures will have to be revised from time to time, and while this in itself is not a handicap, the difficulty is that test results give no indication how to proceed with the revision of Cole factors. A summary rise of all, or even of several, factors will always be a very approximate solution of the question. Tests will always determine the two fundamentals: improvement (1) in boiler evaporation and (2) in steam consumption, irrespective of the boiler and engine design—whether Stephenson or water-tube firebox, high-pressure or low-pressure steam, simple-expansion or compound- or triple-expansion cylinders, or even a turbine instead of cylinders. As soon as these data are known, they can be immediately and directly applied to the suggested method and new constants determined, because the method is based on the same two fundamentals: boiler evaporation and steam consumption. It can not be done with the Cole method. This makes the method suggested in the paper flexible and really universal, although, maybe, not universal in Mr. Sillcox's sense.

C. & O. Panel Side Hopper Cars

IN order to increase the revenue load on some of the older types of hopper cars the Chesapeake & Ohio recently equipped twenty-three 50-ton cars with a type of panel sides developed by the Union Metal Products Company, Chicago. The cars equipped have side stakes on the outside of the car sides which are 3½ in. deep. The side sheets in the intervening panels are dished out 3½ in. making the outside of the side sheet flush with the stakes. In order to prevent coal from banking at the top of the panels while the cars are being unloaded in car dumpers the tops of the sheets taper in to the top side angle on a 20-deg. slope from a vertical line, which is approximately the same as the A. R. A. inside stake car.

The purpose of these panels is to increase the revenue load on older cars which were originally designed with a cubic capacity too small to carry the A. R. A. load limit. The amount of the increase due to the panel sides varies in proportion to the length and height of the sides. In the case of these cars the increase was 53 cu. ft. which made possible an increase in revenue load of 2,756 lb. or 1.38 tons based on coal at 52 lb. per cu. ft. Several tests made on these cars in comparison with plain side cars indicate the increase in revenue load to average 1.354 tons per car.



The installation of panel sides on cars of this type increased the revenue load 2,708 lb.

EDITORIALS

"War Is Hell"

Joseph B. Eastman, federal co-ordinator of transportation, has called the attention of the railroads subject to the Emergency Railroad Transportation Act, 1933, to the labor provisions in Section 7(e) which "do not prohibit any type of labor organization, but they do give railroad employees absolute freedom of choice in joining such organizations without coercion or influence of any description on the part of railroad managements; and they prohibit the latter from using railroad funds to maintain any labor organization. In other words, managements must keep their hands off so far as labor organizations are concerned."

Mr. Eastman has no alternative but to enforce the law. If his interpretation of the statute is correct its enforcement may, in some instances, at least, mean the end of company unions and it will surely mean the unleashing of forces likely to destroy efficiency, lower morale and lead to conflicts which will be no aid to economic recovery and may lead to a series of consequences seriously disturbing to the public welfare.

The people of the United States are in the midst of a drive to end the depression. This drive is being conducted by the National Administration on the theory that the depression constitutes a great national emergency similar to that constituted by war. Emergency powers have been granted the administration and appeals to the public are being made for the purpose of developing the fervor of wartime emotion throughout the country. All citizens are asked to sacrifice their own interests to the end that the one common purpose may be accomplished.

Sixteen years ago this country faced an emergency of at least as great import to the nation and certainly possessing more inherent dramatic qualities than the depression emergency of 1933. One of the measures to meet that emergency was the taking possession of the railroads by the president of the United States and their operation under his direction by the United States Railroad Administration. It became the announced purpose of this Administration to bring about a co-operative effort of the men in the ranks with their officers and supervisors to the end that the nation's transportation machine might be operated with the utmost efficiency. "There must be co-operation," said the Director General in the conclusion of General Order No. 8, "not antagonism; confidence, not suspicion; mutual helpfulness, not grudging performance; just consideration, not arbitrary disregard of each other's rights and feelings; a fine discipline based on mutual respect and sympathy, and an earnest desire to serve the great public faithfully and efficiently. This is the new spirit and purpose which must pervade every part and branch of the National Railway Service."

Presumably to carry out this purpose, certain labor policies were adopted by the Railroad Administration. The spirit pervading these policies is indicated by the following statement, also quoted from General Order No. 8: "No discrimination will be made in the employment, retention or conditions of employment of the employees because of membership or non-membership in labor organizations." In carrying out these policies the Railroad Administration granted wage increases to bring the compensation of railway employees up to the increasing levels of wages effected by the competition for labor

in unregulated industries. It also encouraged the establishment of central organizations of labor through which alone representation could be had before the Railroad Administration. The labor organizations recognized by the Railroad Administration were the brotherhoods and the national unions affiliated with the American Federation of Labor, either then in existence or organized under the fostering influence of the administration.

A review of subsequent events may be worth while to see how effectively this purpose to develop the spirit of co-operation through all branches of the railroad organization was accomplished. One of the early acts of the Director General was the appointment of a wage commission in January, 1918. Early in May of that year this commission recommended wage increases estimated at 300 million dollars a year. The railway shopmen were not satisfied with their share of this first increase or with its distribution among the various classifications of shop workers. Strikes occurred in several places during that month. In spite of the fact that, by the end of the year, increases had been granted aggregating a billion dollars annually there had been a progressive decline in the morale of the men employed on maintenance-of-equipment work and discipline in the shops, engine terminals and repair yards had practically disappeared. When the Railroad Administration became reluctant to grant further wage increases unrest increased until, during the latter half of 1919, there was an outbreak of "illegal" strikes of shopmen on a score or more of railroads involving from a few hundred to several thousand men. Saddling the railroads with the National Agreements as to working conditions also added still further to the breakdown of efficiency. Because of the sharp jurisdictional boundaries between the work of the different crafts this agreement made the conduct of equipment-maintenance operations with any degree of efficiency a practical impossibility.

With the return of private operation under the Transportation Act of 1920 demands for further wage increases, estimated to aggregate another billion dollars annually, brought the matter of wage adjustments and working conditions before the Railroad Labor Board created by the provisions of the Act. The board granted increases totaling 600 million dollars annually. In 1922 when the Labor Board announced wage reductions amounting to 400 million dollars a year and the end of the National Agreements, both to become effective on July 1, the shopmen called a strike for July 1 and the orderly course of transportation was disrupted for a matter of two months. One of the avowed purposes of this strike was to destroy the labor provisions of the Transportation Act.

It was following this strike that the so-called company unions were organized on a large number of railroads. In the development of these organizations it is quite possible that in some instances the abstract rights of employees to join an organization of their own choosing were curtailed by the "coercion or influence" of the managements. Irrespective of this abstract view of the situation, however, the fact remains that under these unions generally good relations between the railway managements and their employees have been developed involving a workable degree of mutual respect and confidence. It is also true that the same workable degree of

mutual respect and confidence has obtained on the roads which continued to maintain relations with the national labor organizations following the end of the shopmen's strike, and it is quite possible that the abstract rights of many individual employees with respect to their choice of labor organizations have been curtailed by the "coercion or influence" of the unions.

The review of these events during and following the life of the United States Railroad Administration suggests certain general conclusions. These may be briefly stated as follows:

1—The complete removal of opposition by managements to the free development of the objectives of the national labor unions does not produce an atmosphere within which co-operation between managements and men can be effected. Rather it destroys all of the delicately adjusted conditions painfully developed between the opposing forces of management and labor which constitute a practical, if not a theoretically ideal, basis of co-operation.

2—Labor organizations have been developed on a militant basis to oppose the selfish interests of industrial managements. The removal of the resistance exerted by the managements releases a force which rushes to the fulfillment of its own selfish objectives like the torrent released by the bursting of a dam.

3—This force, otherwise unopposed, gets beyond the control of the labor leaders themselves. Government opposition is politically inexpedient, until an aroused public opinion demands a halt.

Congress has established, both in the National Industrial Recovery Act and in the Emergency Transportation Act, a labor policy similar to that of the Railroad Administration during the war in that it enjoins managements to keep their hands off so far as labor organizations are concerned, apparently leaving the national unions a free hand to work their will. Is there any reason to expect pious injunctions for the development of good will and co-operation, in the face of such conditions, to be more effective in this national emergency than they were in the great emergency of 1918?

The Interview with the "General Superintendent"

The interview with the General Superintendent, published in the September number of the *Railway Mechanical Engineer* started something—the interviews with officers outside the mechanical department seems invariably to have that sort of reaction. Considering the interview in general, one of our readers in the car department trenchantly remarks:

"Mr. General Superintendent' is not introducing anything new and some of his comments are so old, and the whiskers are so long on them, that he should use a pair of scissors instead of a razor. There is hardly an employee in railroad service today who does not know that the only thing a railroad has to sell is transportation. It is well-known that the entire rank-and-file of the railroads are not only employed to do a regular piece of work, but it is also their duty to advertise the railroad. As a matter of fact, a large percentage of employees has been soliciting business and has also been instrumental in securing business, both freight and passenger. It goes without further argument that in order to retain a business, the patrons must receive service and this applies to any line of business."

By way of explanation it must be admitted that the car department officer quoted is associated with a railroad which maintains a very high standard of service. It speaks volumes for that service and for the morale of

the employees on his railroad to be able frankly and honestly to make so strong a statement.

Passing the Buck Back

One thought variously expressed in the letters we have received is to the effect that the operating department itself is primarily concerned with the responsibility of seeing that the equipment is properly cleaned and conditioned. A car-department representative, for instance, indicates that the cleaning of passenger equipment is an item of the greatest importance, but the appropriation for this work on most roads has been reduced entirely too much. Reducing the present coach cleaning time available to a basis of "per car per day," or "per car per trip," he says, will tell an interesting story and clearly demonstrate that there is a real basis for complaint. Another car-department officer suggests that with proper supervision—presumably on the part of the operating department—any complaints from passengers as to the tidiness of the coaches can be reduced to a minimum.

Interior Decoration

Improving the appearance of the equipment and providing more convenient and more comfortable facilities costs money and some of the car-department representatives are a bit skeptical as to whether such improvements will justify themselves in increased travel and revenues. For instance, one officer puts it in this way: "I might state that in the last eight or ten years I observed on some of the railroads that considerable money has been spent in doing just the things that the General Superintendent has suggested. In some instances the interior of passenger equipment cars has been redesigned and redecorated, but I have sometimes wondered as to what real interest the traveling public takes in these improvements. The main item with the public is not the general appearance of the equipment, but rather, what effect the trip is going to have on their pocketbooks."

Another car-department representative expresses much the same thought in this way: "In riding passenger trains on our own and other roads I find that the public is not so vitally interested in the dressing up of passenger equipment, and the one and only move that will get them to again ride trains is a reduction in fares, as this is the thing that talks loudest."

Another car department representative expresses himself thus: "Present standards on passenger equipment of the older type, built prior to 1925, are based largely upon tradition. By that I refer to such details as seats, toilet arrangements, and the like. With ordinary maintenance such seats are as good as they ever were for an almost indefinite life. To alter the style or construction of the seats, however, or to replace them with something more up-to-date—the bucket type, for example—would involve a relatively high investment, out of proportion, I fear, to any increase in revenue that could be secured."

It would be interesting to bring the traffic department into this discussion, to see whether, in its opinion, an aggressive publicity campaign with some reduction of rates and with improved equipment would bring back a sufficient amount of revenue to put the passenger traffic on a good paying basis. Apparently this cannot be done by any one effort, but must depend upon a combination of several factors which will make railroad travel more attractive and encourage the traveling public to become more "railroad-travel-minded."

One car department representative has this comment on floor coverings: "Nothing that I could imagine is more insanitary than carpets or aisle runners in ordinary

coaches. A well laid composition floor, especially if the aisle section is of a contrasting color to the main body color, is pleasing to the eye and can be kept clean with little difficulty. A wooden floor certainly does not please the eye after the paint in the aisle and between the seats has worn through."

Exterior Decoration of Passenger Equipment

If there is any one thing that is impressed upon the mind of an editor of a railroad publication, it is that many people who are not employed by the railways are very much interested in the design and appearance of railway equipment. This is indicated by a steady stream of correspondence from such people and by the great crowds that are keen to visit special trains or locomotives when they are placed on exhibition at terminals or at expositions. Undoubtedly these folks will take keen exception to the following statement made by a car department officer:

"I can appreciate that on the inside of the car, whether on a long or a short trip, passengers have an opportunity to observe the general arrangement and trimmings of the car. The outside painting, decorating, etc., which require additional cost in maintaining and keeping the paint clean when done in light colors, as compared with the darker colors, seems to me to be of no real benefit, except to the farmer who may be out plowing his field, or who may look at the train as it passes his property. This man would probably not use the train over once or twice a year; consequently I cannot see where any additional revenues would be derived from this additional expense."

Noise—and More Noise

One of our correspondents, a car-department representative, agrees that the noise-making parts of coaches are a nuisance and "on cars in long or overnight runs, an abomination." Apparently he has given some considerable study to this problem, because he has carefully listed the noise makers in the order of their importance, beginning with the worst. He heads the list with buffers, the noisy parts of which include the side stems, which wear rapidly on the bottom surface where they come in contact with the end sill. He emphasizes the fact that "the friction between face plates and badly worn side stems causes a thumping sound sufficient to wake the dead."

The second item on his list is the center plates, which are noisy largely because of improper design. Apparently, if this difficulty is to be overcome, the designer must get busy and produce center plates which can readily be lubricated. Next in order come the side bearings, brake rigging and generator suspension pins, which, however, "can be kept quiet by frequent and comparatively inexpensive lubrication." Metal sash, if properly fitted, will overcome the rattling of windows. This car-department representative is in thorough agreement with the General Superintendent as to the necessity for overcoming the noise of trap-door springs and signal valves.

That the employees in the operating department can co-operate to splendid advantage in reducing and eliminating the obnoxious noises on the train, is indicated by the following comment from a car-department officer: "As to the noisy and squeaky windows and such features as that, it would seem that the co-operative effort of general and division officers could overcome the troublesome items by reporting those cases in detail to the terminal maintenance forces. A squeaky window or a squeaky door can hardly be detected when the car is standing in the terminal yards. On the other hand, direct advice to the terminal yard forces as to just what

is squeaking, when such conditions are observed by officers and inspectors on the road, will make it possible to correct those features which are objectionable to the public."

Smoke and Cinders

There seems to be a general agreement that much can be done to mitigate the smoke nuisance if the crews are properly educated. Under the best of conditions, however, there will always be an occasional bit of smoke. A mechanical officer suggests that the fine ash nuisance is even worse than the smoke, and as far as he knows nothing has yet been found to relieve this nuisance.

From the standpoint of the passenger, air conditioning, with the tight windows, will, of course, protect him from the smoke and dirt nuisance. Incidentally, so far as our correspondence is concerned, the car department officers seem to agree that air conditioning is a most desirable feature.

The Next Step

Those who have studied the problem of locomotive maintenance as it relates to present-day railroad operation seem willing to accede to the suggestion that the question of locomotive repair costs—now the largest single item of operating expense—is one of sufficient importance to warrant specialized effort with the ultimate reduction of these costs as an objective. Those who agree without hesitation that such is the case are not quite so willing to concede that anyone has clearly pointed a practical way to make substantial reductions in locomotive repair costs.

Most problems, especially those involving the operation of large properties or industries such as railroads, seem extremely complicated and quite often insolvable when viewed in their entirety but once broken down into separate parts and viewed as parts a solution appears. The problem of locomotive repairs is a complicated one with many ramifications and many railroad men will say "Yes, something must be done about reducing costs but where shall we start?"

Two months ago, an editorial in these columns suggested that the way to a solution of this problem involved the question of the proper relation of locomotive design to maintenance, the question of the proper facilities for maintenance and, finally, the importance of the proper attitude of management toward the necessity of solving the problem. In part that editorial said that "In spite of the fact that many shops and engine terminals have been abandoned and consolidated with other facilities, we still have in service repair facilities that are, in proportion, just as obsolete as the locomotives they are intended to maintain. What is needed is a study made in some manner that will assure the formulation of intelligent maintenance policies—in relation to economical locomotive operation—and the utilization of the best methods so far developed for the industry as a whole." One mechanical officer in commenting on that editorial said that "before this question can be dealt with properly, probably it would be necessary to have a complete check made of the operating problems of each railroad; the class of locomotive equipment used; the possibilities of lengthening engine runs and the shop facilities they have available for the repairs to the equipment they have in use." This officer adds one very important point to the original analysis but is of the opinion that before policies can be formulated a complete check should be made. Is not this, then, the place to start?

THE READER'S PAGE

Speed Up the Freight Trains

TO THE EDITOR:

The varied viewpoints revealed under your heading "More Reactions to RTO's Suggestion" in the *Railway Mechanical Engineer* of August, 1933, are most interesting, especially as they reveal how we may hinder rather than help toward the progress which all the writers obviously wish for.

What is the first reason for turning down or deferring the acceptance of a new design which, although inherently practical, is, nevertheless, radical? Isn't it frequently this? "We cannot scrap all the existing equipment and this idea will not fit in with present arrangements."

The railroads cannot expect to satisfy the public with passenger movements at 110 m.p.h. if freight does not speed up to a corresponding degree. If one of two competing lines were running streamlined freight trains at 80 m.p.h. or more, and doing it economically, wouldn't it have a remarkable advantage over the slower, more heavily equipped line?

It is pretty discouraging to think that our prominent equipment and traffic men are worrying about variations on a form already known to be outmoded when we are on the threshold of a new era in railroading—an era of streamlining, lighter weight and higher speed. Yet if these modifications are made, fast streamlined freight trains are that much further in the future.

And does not faster freight movement mean fewer freight cars to handle a given tonnage per month?

We won't have to replace every existing locomotive and freight car with the new equipment. Express, automobile, refrigerator and similar fast moving units would be the first built according to new lines.

Let us watch the Union Pacific and Burlington experiments and plan our freight cars accordingly. The cylindrical form must come eventually—and freight movement will ever remain the backbone of the industry. Why increase the burden of the future when now is the ideal time to begin making changes? Radical changes, gentlemen, not just picayune variations.

LEONARD C. RENNIE,
Editor, The Power Specialist.

There Is a Chance

TO THE EDITOR:

I thought the apprentice question had been settled but here comes a man who, on page 329 of the September number of the *Railway Mechanical Engineer*, says let's train a man to do one job and train another to become his boss. Just like that!

Here the multiplicity of occurrences in a growing boy's life has been cast aside, regardless of the fact that each event may affect the molding of his character and direct him into channels of work where he might become more useful than if forced into any single line of endeavor. The railroads, in training them, give apprentices a chance in life. "Hard-boiled," your September correspondent, says: "It is unjust to hold out promises of a foreman's job to an apprentice when someone has to die, get fired, or be demoted before there is a chance for him." One might appropriately

ask at this point if men no longer die, or get fired, or become demoted, or if vacancies are not created in many other ways. There is a chance for promotion, but that is beside the point because apprentice systems on American railroads, excepting special apprenticeships, are established to train mechanics and not foremen, and because many apprentice-trained mechanics become supervisors young men aspire to these positions.

In receiving his training the apprentice learns to operate practically every type of equipment in a repair shop and also becomes acquainted with methods of repairing machinery, self-propelled motor cars with internal-combustion engines, and locomotives with all their appurtenances, much of which is encountered in many shops, where the precise item of locomotive repairing is not a factor. Can you visualize a man with this training asking for a job in competition with one who says: "I'm a milling-machine hand"? For the privilege of being able to lay claim to such a wide and varied experience, the apprentice is willing to undergo a four-year apprenticeship, during which time he works at a relatively low rate of pay, thus producing quality work at a profit for the railroad in return for his training. This, "Hard-boiled," is what there is to offer the boys when they have completed their period of low-paid training. It is not fair to say that apprentice courses are valueless because men with this training have been out of work, for highly educated men, specially trained in single fields of endeavor, have been unemployed for long periods.

On the other hand, it may be well to train specialists in an automobile factory where mass production can be accomplished because of the exact duplication of work on any single job. But in a locomotive shop, where each job is a repair proposition, the mechanic must be trained for a diversity of work which may require the application of a thorough knowledge of every phase of the job and not simply an understanding of how to make a part, or machine a piece, to a standard micrometer gage, made and set for him by a man with superior training. If locomotive repair work was of the latter nature the railroads might or might not benefit by taking a high school boy and making him a machinist in six weeks as "Hard-boiled" suggests doing. Would you trust a high school boy, with six weeks' training and practically no mechanical background, with the job of reboring the cylinder block of your automobile? No more than a foreman in a locomotive shop would permit the same man to rebore valve chambers or cylinders, or handle a hundred other jobs of like importance. I am inclined to believe that 95 per cent of the jobs in a locomotive shop, instead of 5 per cent as estimated by "Hard-boiled," require months, and in some instances years, of training before a man is capable of doing satisfactory work in a reasonable period of time. Then, again, an apprentice-trained mechanic often acquires qualities that make him foremanship timber. This may or may not be the case should a select few be chosen for specialized training as foremen.

If one thus assures himself that an apprentice system is profitable to a railroad, that it gives a young man a training which places him in a position to start life as a journeyman mechanic fitted for a variety of jobs, and that it endows him with certain characteristics which may be useful in elevating his station in life, then the matter is most serious and is not "most laughable and absurd."

KEMPTON CODY.

With the Car Foremen and Inspectors

Shop Devices for Reclaiming Air Hose

THE bolt cutter, illustrated, has been developed and used at the Corwith (Ill.) reclamation plant of the Atchison, Topeka & Santa Fe for cutting the small clamp bolts in air hose, signal hose, etc., preliminary to stripping the fittings from defective hose. It consists of the usual carbon-steel cutting blades, bolted in a shear, installed in the bench where air-brake hose are repaired. Operation of the shear is obtained by means of a 10-in. air cylinder and suitable lever connections underneath the bench. A small reservoir under the bench provides



Bolt cutter operated by air with foot-treadle connection to the control valve

storage capacity for the air, the pressure of which, when it reaches the cylinder, is limited to 15 lb. by a safety valve.

The feature of particular interest about this shear is the arrangement for operating it by means of an air control valve and foot-treadle arrangement, leaving both of the operator's hands free to handle the hose. Admission of air from the storage reservoir to the brake cylinder and its subsequent exhaust to the atmosphere is controlled by a $\frac{3}{4}$ -in. straight-air brake valve, from which the handle and quadrant have been removed and

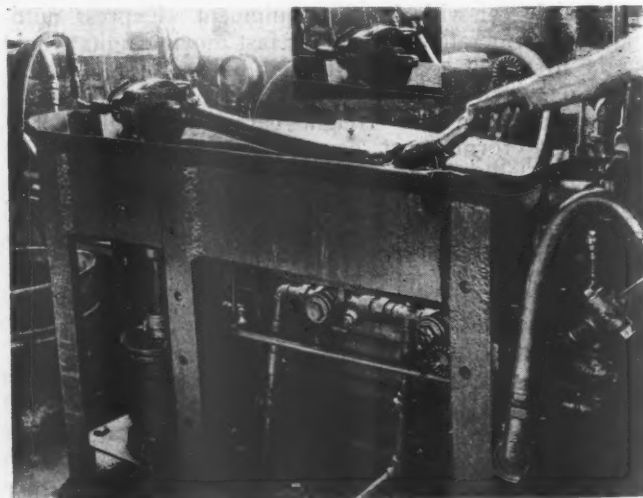
replaced by a sprocket gear and a chain connected at one end to a long coil spring and at the other end to a bracket on the foot treadle bar. The movement of this treadle and bar down, under foot pressure, moves the brake valve to application position and applies air in the brake cylinder, operating the shear and cutting off the clamp bolt. As soon as pressure is released, the coil spring pulls the chain and sprocket back to their original position, the brake valve then releasing cylinder pressure and permitting the brake cylinder spring to return the piston and open the shear.

The air-brake department at the Corwith reclamation plant is also equipped with efficient devices and tools for stripping the hose fittings, gaging and reclaiming those fittings which are in suitable condition for further use and reassembling fittings in new hose.

Hose Testing Device

A machine for testing newly-mounted hose and fittings is also of special interest, comprising, as shown in the second illustration, a welded sheet-metal tank, 10 in. wide by 8 in. high by 48 in. long, supported at a convenient height on an angle-iron frame which carries the testing head, 6-in. by 10-in. air cylinder, necessary operating valves, pipes, etc.

The main operating head, shown at the left of the illustration, is in reality a triple-purpose head, performing



Convenient hose testing device—The insert shows the testing head before the application of the hose

three functions: First, to hold the hose, with the nipple end placed over the hollow spindle and the other end closed by a capped standard coupling; second, to apply air pressure inside the hose, and, third, to lower the head and hose with the mounted fittings into a water bath, which will immediately indicate any leaks due to sand holes or defects in the castings or hose. All of these operations are controlled by the straight-air brake valve shown at the right of the tank. The first movement of the handle of this valve after a hose nipple is applied over the spindle causes a rubber disc to expand inside the nipple, making a water-tight joint and at

the same time exerting sufficient pressure to hold the nipple on the spindle while pressure is applied. Further movement of the brake valve handle admits air pressure up to 60 lb. in the pipe and immerses the head and hose in the water bath. Returning the handle to release position causes the head to return to its upper position and release the hose.

The line air pressure is shown by the large gage and the test pressure by the small gage at the testing head. A steam pipe and hose are also shown at the extreme left of the illustration, being provided to supply steam for tempering the water during cold weather. Next to the operating valve at the other end of the tank is a hose connection for blowing off any defective fittings which may be discovered. The feed valves under the tank are used for limiting the pressures as required in various parts of the testing head. A safety valve protects against excessive pressure in the air cylinder. A close-up view of the testing head before application of the hose nipple is shown in an insert in the upper part of the illustration.

The general construction of this hose-testing device is fairly clear from a study of the illustration, but, as a matter of fact, the detailed piping and valve arrangement necessary to produce proper timing and satisfactory operation were developed only after considerable experiment.

A Hand Truck with Third Wheel

HEAVY materials, particularly metal sheets, are much easier to handle with a hand truck if the latter is equipped with a third wheel. The truck is tipped forward as usual to load, but in moving the load about the weight rests entirely on the wheels, instead of partly on the workman's arms. The shank of the castor wheel is inserted through holes in two short cross sections of $\frac{1}{4}$ -in. by 2-in. bar welded between the long

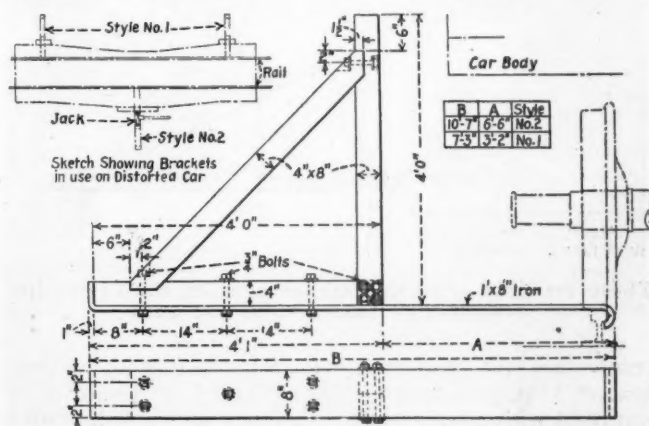


The third wheel relieves the workman of holding the load

braces of the same material. A large washer, pin and cotter key at the top of the castor shank hold it in place. The long braces are welded to the angles which form the principal part of the truck handles. A socket for the wooden crooks is made by welding a short section of angle to each of the handle angles at the end.

Car Straightening Devices

ONE of the illustrations shows a bracket for straightening car frames, developed at the Silvis (Ill.) shops of the Chicago, Rock Island & Pacific. This bracket consists of a heavy 1-in. by 8-in. steel plate of the required length, bent to one-half round at one end to engage the rail and bent to the other end at right angles to serve as a stop for the heavy wood-framed 4-in by 8-in. right-angle bracket which is secured to the base plate by five $\frac{3}{4}$ -in. bolts. The legs of the bracket are 4 ft. each way and the frame joints are held together by suitable $\frac{3}{4}$ -in. bolts of the required length, as illustrated. The bracket is made in two styles, the only



Bracket for straightening car frames

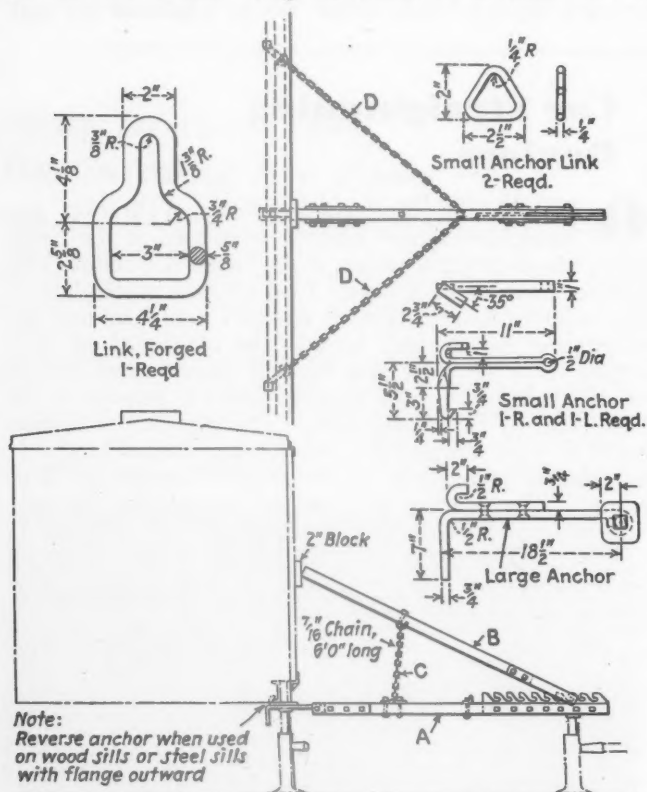
difference being changes in dimensions *A* and *B*, as shown in the table. Style 1 is provided for backing-up purposes and Style 2 for jacking purposes.

In operation, this device is used for straightening car frames which may have become bent in service. The hook end of the Style-2 bracket is placed over the rail at the center of the bend. The other end of the bracket is blocked level with the top of the rail, which brings the upright leg of the bracket in a vertical position. Then a jack is placed between the upright and the frame of the car, pressure being applied until the frame is straightened. In order to hold the ends of the car on the opposite side during this process, a Style-1 bracket is applied near each end of the frame. The Style-1 brackets contact the car sides directly and do not require blocks or jacking of any kind. The use of the two different styles of bracket is clearly shown in the illustration.

Straightening Bulged Car Sides

Another device, also developed at Silvis shops, for straightening the bulged sides and ends of cars is shown in the second illustration. It consists essentially of a composite steel-and-wood base member *A*, anchored to the car sill at one end and supported on diagonal beam *B*; supporting chain *C*; and two bracing chains *DD*. The upper end of beam *B* rests against a 2-in. block at the point of maximum deflection of the bulged car side or end, and it is obvious that the operation of the jack under

The base beam *A* consists of a piece of oak 4 in. square by 10 ft. long, reinforced with two steel straps at the left end and slotted along the center at the other end to



These drawings show the manner of using the device for straightening bulged sides and ends

receive a $\frac{1}{4}$ -in. steel rack 4 ft. 3 in. long, with notches spaced $\frac{1}{2}$ in. on center. The left end of beam *A* is equipped with a large anchor designed with a half-round hook to engage the side-sill flange and also having a substantial right-angle bend for use with wood sills or steel sills having the flange outward. Details of this anchor arrangement are shown enlarged at one point in the drawing. Post *B*, also of oak, 4 in. square, is 10 ft. 1 in. long, slotted along the center line at the lower end to accommodate the steel rack and provided with a bolt and pipe washer to engage any one of the notches of the rack. Chain *C*, 6 ft. long and made of $\frac{1}{16}$ -in. stock, is attached to post *B* by a $\frac{1}{2}$ -in. J-bolt and to base beam *A* by a link and strap, the link being shown separately in the upper left corner of the drawing. This link construction obviously permits adjusting the length of chain *C*, as necessary. Chains *DD* are 8 ft. 6 in. long, made of $\frac{1}{4}$ -in. stock, permanently anchored to post *A* and equipped with special small anchors designed to hold when pulling at an angle on the side-sill flange. The detailed construction of these small anchors is shown in the drawing.

REDUCED costs of sanding and surfacing operations in railroad shops are made possible through the introduction of electrocoated abrasives (sandpapers) used on such jobs as sanding wood, preparing metal surfaces for paint, cleaning and rust removal, truing up

Savings are indicated by tests made by the group of abrasive manufacturers who are placing electrocoated sandpaper on the market. Working in actual producing shops, they have found that the product increases the efficiency of sanding and finishing operations over a range from 20 to 60 per cent, depending upon the job done.

This product is the result of a recently perfected method of applying an abrasive coating by means of an electrostatic field which is maintained by means of current of 50,000 or more volts potential acting between two plate electrodes. The lower electrode is the negative. Over this the abrasive particles are conveyed on a belt. As they enter the field they are electrified. As a consequence, they all stand on end and take places at equal distances from each other. The force of the field then propels them at high speed toward the upper, positive electrode. Before reaching this they strike a glue-covered paper or cloth which is being passed at an appropriate speed under the upper electrode. Here they fix themselves securely and the sandpaper then passes on to the drier.

By the use of this method a coated abrasive is obtained in which all the abrasive grains are set on end with their sharpest cutting edges and points presented to the work. These grains are also uniformly distributed and evenly spaced all over the surface of the backing.

Electrocoated abrasives will be manufactured by several well-known companies and will be marketed through dealers and supply houses.

THE latest advances in eye protection for oxyacetylene welding and cutting have been embodied in the Oxweld No. 15 welding spectacles and a new lens, type AA, recently announced by the Linde Air Products Company, 30 East Forty-Second street, New York.

In this type spectacle the lenses are mounted in a natural canvas-bakelite frame and are 50 mm. in diameter. This width permits a wider angle of vision and gives greater protection against light and sparks.

The temples (bows) are covered with insulating material and the frame is non-flammable and does not conduct heat. By means of a snap device where the temples meet the frame it is possible to spread the frame and change lenses in a few seconds. Oxweld type AA, A or B lenses can be furnished in the same colors and shades as for the Oxweld No. 12 goggles. The type AA lens, flat ground and polished, is made in light, medium and dark green shades.

The use of the type AA lens is recommended where safety codes prevent the use of other lenses which are not flat ground and polished, although equally effective otherwise. This lens is designed to conform to all code requirements, including those of the federal government.

WHY DON'T THEY DO THIS WITH ALL THE RAILWAYS' SURPLUS LOCOMOTIVE POWER?—The first locomotive ever to be used in the manufacture of beer was working 24 hr. a day at the plant of the Hazelwood Beverage Company, Pittsburgh, Pa., recently. With orders on hand exceeding the capacity of the plant, an auxiliary source of steam had to be secured. A Baltimore & Ohio locomotive was leased for the purpose, and, from all reports, it did its job well.

Hopper Car Scaffold Support

WHEN extensive repairs are being made to hopper or gondola cars the scaffold support shown in the illustration will be found to be an indispensable part of the equipment for the fitting and riveting gangs. It is placed over the top angle of the car in the position shown in the photograph, the flat side resting against



This scaffold support is hooked over the side of an open-top car

the car side. One or two planks are placed between two or three of the supports and act as a scaffold for the men who are fittings, reaming or riveting the car sides.

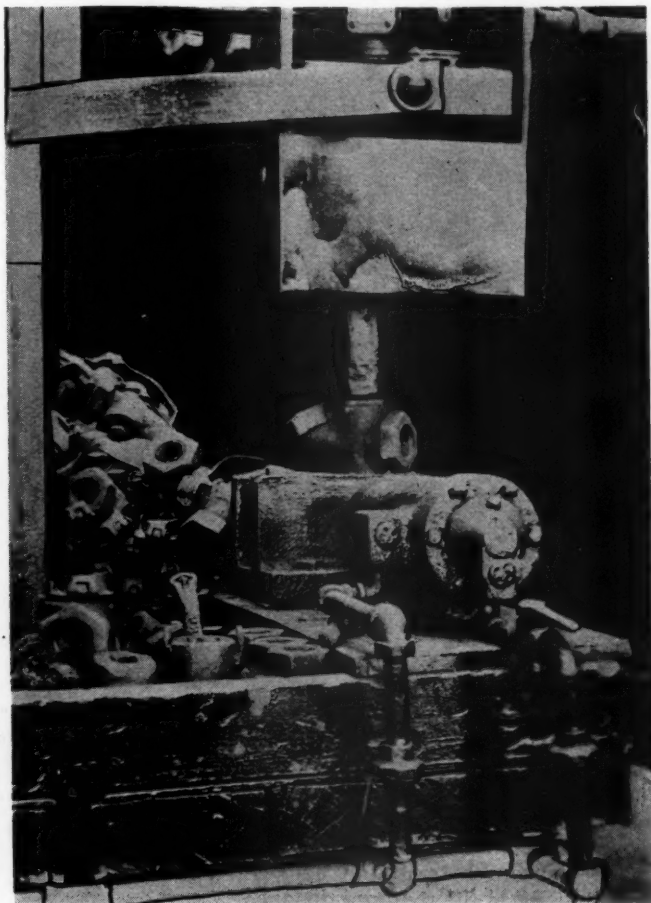
The scaffold support can be of any depth, however 36 in., is most desirable when repairing hopper cars as it permits the workmen to reach to the top angle of the car side while on the scaffold and the balance of the side can be reached from the ground. It is made from $\frac{1}{2}$ in., by $2\frac{1}{2}$ in., flat wrought iron and formed as shown.

Pneumatic Device for Stripping Angle Cocks

A PNEUMATIC vise, together with a power wrench for stripping angle and cut-out cocks on the repair bench, is shown in the illustration. An ordinary pneumatic motor is mounted overhead and is equipped with a socket wrench which fits the bottom nut and cap on angle and cut-out cocks. The workman merely places the nut into the socket wrench and applies the air to the vise and clamps the angle cock in position as shown. The nut can then either be removed or replaced by operating the air valve controlling the reversible motor overhead.

Where parts of train-line nipples have been broken off in the angle cock these can also be removed by merely applying a gouging tool to the socket wrench and placing the angle cock in the vise in much the same manner as is done when the cap is removed.

The installation of this device on the work bench at



Angle cocks are easily dismantled by this device

the angle and cut-out cock shop will increase the efficiency of the workmen and is said to have provided an increase of 35 per cent in the shop output when installed in the air-brake repair shop of an eastern railroad.

Feed Tank for Heavy Finishing Operations

THE DeVilbiss Company, Toledo, Ohio, has recently placed on the market a 60-gal. pressure feed tank for heavy finishing operations. The tank is $39\frac{1}{4}$ in. high and 24 in. wide. The proportions of this size result in easier handling in filling and cleaning operations. The walls are of .125 open-hearth steel, heavily galvanized inside and out. A pressed-steel cadmium plated cover has twelve clamps. A new style revolving agitator works close to the bottom of the tank, preventing the possibility of accumulation of pigment. Regular equipment includes pressure regulator and gage, safety valve, relief valve, air-inlet valve, two air and two fluid outlets. It can be supplied either with top or with bottom outlet and with or without gage glass to indicate the level of material within the tank.

A Support for a Punch Press

IN handling metal bars and angles, etc., at the punch machine the work is made easier by the use of a tee extending about 8 ft. each way from the machine and supported at the end by two bars welded on four legs. A measuring stop is welded to the top of the tee at one end and a guide, made from a short section of channel,



Support for angles and flat stock at the punch press

is welded lengthwise at the other end. At each side of the machine a roller, made from 1-in. pipe 8 in. long on a bolt inserted through a bracket, is used to make the movement of the material easy. The brackets are shaped on the bottom to grip the flanges of the tee and are moved along to the required distance.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. R. A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Bill for Cleaning and Lubrication At Intermediate Terminals

Through line chair-car service was maintained between St. Louis, Mo., and Oakland, Calif., during several months of 1931 via the Missouri Pacific, Denver & Rio Grande Western and Western Pacific, each company agreeing to charge the line comprising this run for expense incurred as authorized under Passenger Car Rules 6 and 9. The D. & R. G. W. has, in many of its bills, charged the Missouri Pacific for expenses at its St. Louis City division terminal to cover lubrication and cleaning of chair cars on a basis proportional to mileage. The Missouri Pacific has paid these bills under protest and objected to the charges, which are claimed to be of an arbitrary nature not authorized by the rules, in view of the fact that the D. & R. G. W. is an intermediate road

in this operation. The Missouri Pacific contended that inasmuch as certain charges were rendered on a basis of 25 cents per car for exterior cleaning and 25 cents per car for cost of lubrication, these charges were arbitrary charges not conforming to the class of work required for the labor allowance permitted under P. C. Rule 21. The cars laid over at Salt Lake City approximately 15 min. each way, which the Missouri Pacific contended did not permit a thorough job of cleaning the exterior as provided under the aforementioned rule. The Missouri Pacific further contended that there is no authority for the charge for cleaning unless the work is performed completely, citing a decision rendered in Arbitration Case 854 to the effect that "lubrication, etc., at intermediate points are proper, provided, to justify the M. C. B. charges for such work, the cleaning was as efficiently done at the intermediate as at the extreme terminal." In referring to the charges of 25 cents per car for lubrication the Missouri Pacific contended that there is no authority for such charge and cited P. C. Rule 9 as allowing 50 cents labor for terminal lubrication on cars in through service, and that they considered this charge as applicable at origin and destination, and, further, that the lubrication furnished at intermediate points constitutes a service treatment and should be taken care of on the part of all lines involved under P. C. Rule 1. In its statement the D. & R. G. W. called attention to the fact that in establishing the service mentioned it was agreed that the three roads should each place two chair cars in through-line service, and that the expense of servicing such cars should be pro-rated on a mileage basis in accordance with P. C. Rules 3, 6 and 9. The D. & R. G. W. finds it necessary to have an extra force of coach cleaners and oilers meet the trains at Salt Lake City to clean, supply and lubricate these cars during the 15-min. layover. That road considered the actual expense incurred at this intermediate terminal as properly chargeable to line service expense, and said that its costs exceeded the 25 cents per car for lubrication and the flat rate of 25 cents per car for lubrication which was charged in its bills against the Missouri Pacific and the Western Pacific. They drew attention to the fact that these charges were based on actual costs for labor and not on the price specified under Rule P. C. 21, which they understood applied to work performed at terminals of origin and destination, whereas under P. C. Rule 9 they were of the belief that the intermediate road may charge against line service the actual costs involved for cleaning and lubrication of cars operated in through runs. The D. & R. G. W. further pointed out that P. C. Rule 9 does not differentiate between intermediate and destination terminals and contended that it was clearly intended under this rule that such expense incurred by all roads interested in line service should be pro-rated to all on a mileage basis; otherwise, why was the note inserted in the rule making the handling line responsible for ordinary cleaning, etc., except on cars in line service?

A decision was rendered by the Arbitration Committee on November 4, 1932, as follows: "The contention of the Denver & Rio Grande Western is sustained and their bill should be paid. Passenger Rule 9, Sections (a) and (d) and note under Section (e) apply. This note makes handling line responsible for ordinary daily cleaning, sweeping and dusting interior, wiping down or washing exterior, cleaning windows, etc., when car is not operated in line service—therefore, expense incurred for doing this work when car is in line service should be pro-rated to the roads interested in the line on a mileage basis."—Case No. 1718, *Missouri Pacific vs. Denver & Rio Grande Western*.

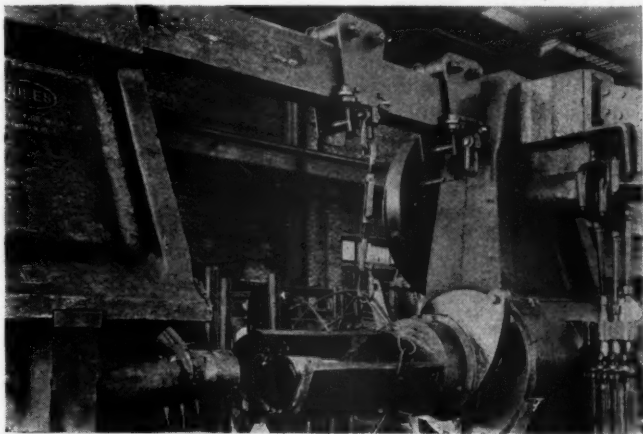
In the Back Shop and Enginehouse

Wheel-Shop Devices

A NUMBER of devices developed in the wheel-repair department at the Chicago shops of the Chicago & North Western are shown in the illustrations. The first of these affords a general view of the wheel shop with the 800-ton Niles hydraulic press in the foreground and tire-storage racks in the background. Particular attention is called to these racks which consist simply of rail sections bent to U-shape and bolted back to back and to the floor in sufficient numbers to take care of the various sizes of tires commonly used at this shop. Two lines of rail sections are placed parallel and 31 in. apart, being braced vertically by stayrods of one-inch round iron threaded on each end and equipped with positioning nuts. The use of this type of rack permits storing tires safely in a position almost vertical, taking relatively little floor space and facilitating calipering and inspection.

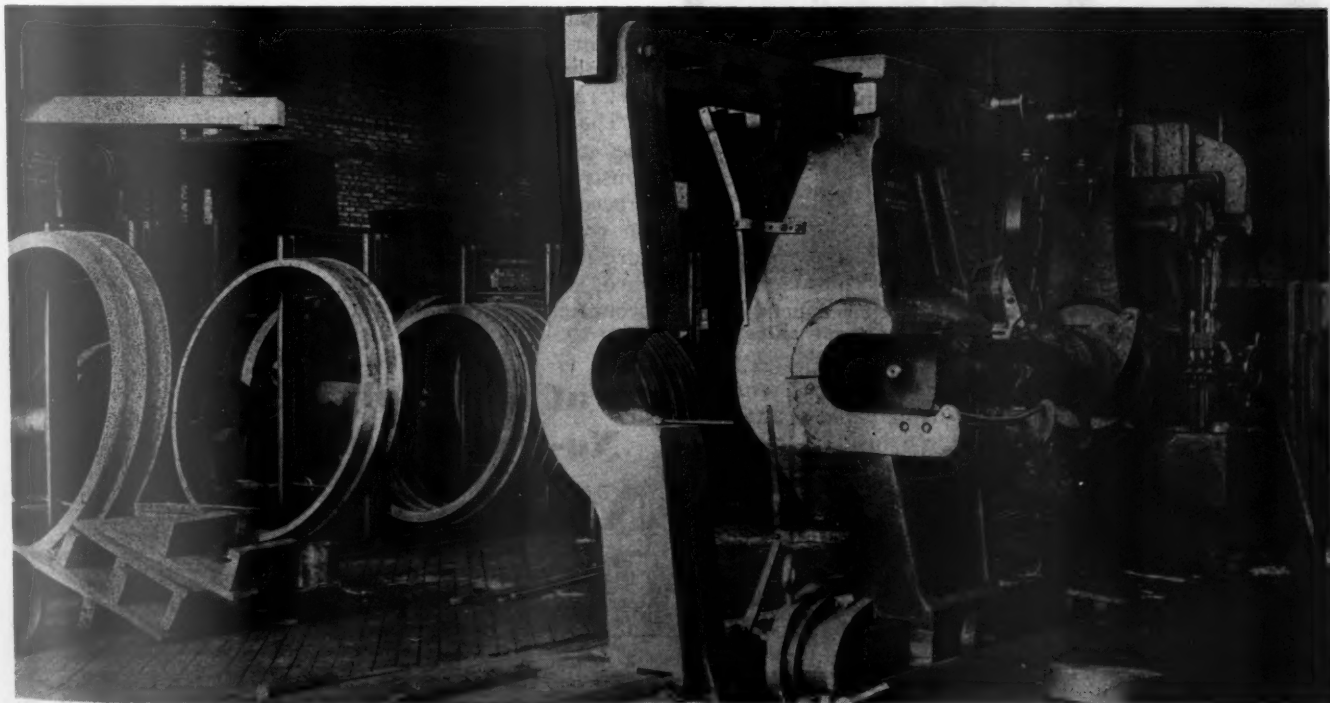
The close-up view of the wheel press equipped for removing crank pins is particularly interesting because this method avoids the practice still followed in some shops of pressing crank pins through the wheel centers in the same direction as applied. This often results in enlarging the hole, since practically all crank-pin holes are slightly tapered, being large at the hub face. The preferred practice is to back out the pin in the reverse direction from which it was applied. For this purpose, a special cap and trough casting is applied to the ram,

being supported by a sling from a small carriage on the upper tension bar. This cast-steel trough, with an inside diameter of $11\frac{1}{2}$ in. and a length of 22 in., bears against the wheel center during the pressing off operation and is large enough to receive the largest crank



The press equipment for removing crank pins from the outside

pin after it is pressed out. A steel back-up block and horizontal post, held in the movable resistance beam of the press, as illustrated, bears against the inner end of the crank pin and, under operation of the ram, the wheel center is pressed off the pin in the reverse direc-

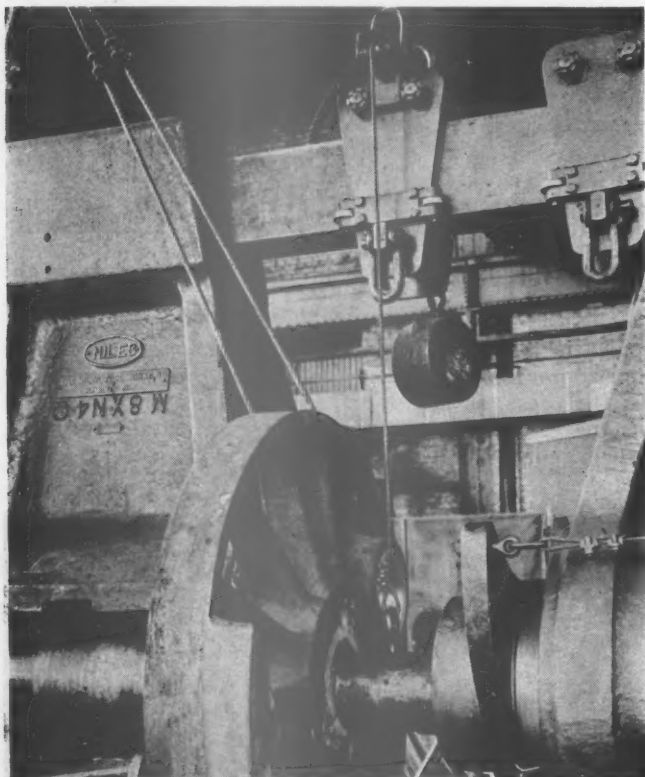


General view of Niles 800-ton wheel press at the Chicago shops of the Chicago & North Western—Tire storage racks in the background

tion from which the pin was applied. The back-up post is so arranged that various adapter blocks can be used to take care of different sizes of crank pins.

The small movable carriages on the top tension bar of this press are worthy of special note because the upper rolls are equipped with ball bearings. An additional feature designed to prevent binding and afford easy movement of the carriage is the provision of double rolls at the bottom of the front cover plate and one roll (not shown) at the top of the back plate. The necessity for providing these rolls rests in the fact that the U-bolt which supports the sling and cast-steel trough, wheel center, or other heavy part, is off-center from the carriage, and, without the rolls, the side plates of the carriage would be pulled against the upper tension bar and cause sufficient friction so that the carriage would be difficult to move.

The third illustration, which shows the operation of pressing out an axle, also illustrates an ingenious and very satisfactory method of counterbalancing the steel block which is used between the axle and the ram of the press. This block is equipped with a projection which

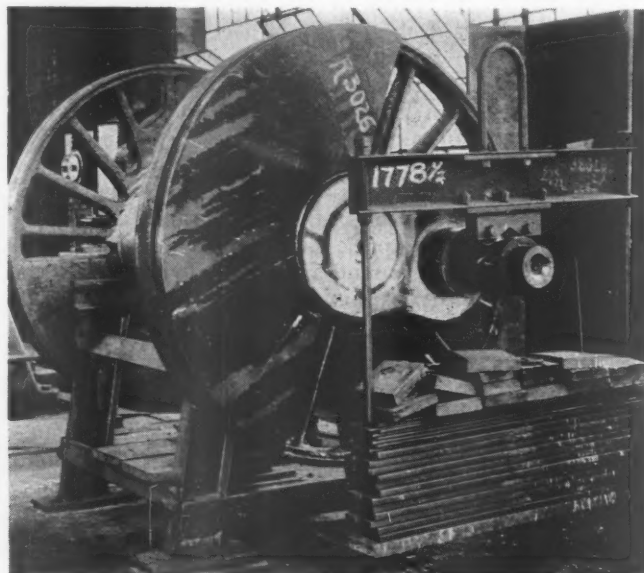


Convenient and safe method of counterbalancing the hollow steel block used in pressing out axles

forces out the key at the same time the axle is removed and the I-bolt, to which the supporting cable is attached, is threaded into a steel sliding piece inside a cavity in the block and is capable of movement longitudinally in a slot so that, as the axle is pressed out, the I-bolt moves in the slot and is not sheared off. Referring to the illustration, it will be noted that the supporting cable is carried over two rolls on the top of the carriage and has a counterweight at the other end, which not only makes it easy to raise or lower the block but avoids the necessity of holding it to prevent dropping when the pressure on the ram is just being applied or released.

The device used in counterbalancing locomotive driving wheels is also shown in the fourth illustration. The driving wheels are the main wheels for the North West-

ern Class-H, 4-8-4 type locomotive, which are cross-counterbalanced to 10 deg. The counterbalancing device, or weighing beam, consists of a channel-iron beam and U-bolt for movement by means of the shop crane, the beam being provided with two ball-bearing rolls which bear on the crank pin and serve to minimize friction. Two vertical rods, bolted through a bottom spacing plate, carry the load. The plates, which are slotted at the ends to engage the round side rods of the device, are 6 in. wide and of varying thicknesses, each plate being weighed and stencilled. In certain cases, such as that of the main driving wheels in the illustration, the counterweight required is so large that additional lead blocks are laid on top of the plate to effect a balance. In this particular instance, the iron plates weigh $1,778\frac{1}{2}$



Roller-bearing weighing beam used in counterbalancing driving wheels

lb., the lead $558\frac{1}{2}$ lb. and the weighing-beam frame, rods and base, 383 lb., a total of 2,720 lb. This total weight was checked by placing the loaded weighing beam directly on a pair of Fairbanks-Morse scales conveniently located in the wheel shop.

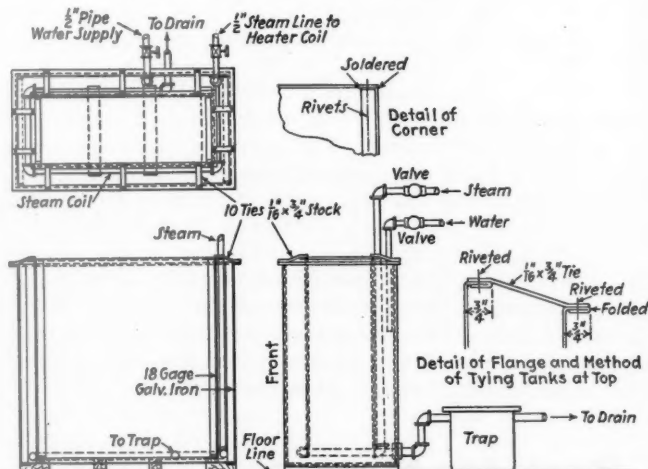
The stand used for supporting driving wheels during the counterbalancing operation is of particularly rigid construction, comprising two steel rails bolted to heavily braced I-beams which are welded to floor plates mounted on concrete foundation blocks. The rail sections are carefully levelled and ground to a smooth, straight surface, so that the operation of counterbalancing can be accurately performed.

Vat for Applying No-Ox-Id Compound

NO-OX-ID compound is being applied on machine-finished locomotive and car parts which it is essential to keep from rusting. The standard practice card of at least one midwestern carrier requires that this application must be made using a special steam-heated vat, as shown in the illustration. The material, to which the compound is applied, is dipped at a temperature of from 160 to 180 deg F., and then allowed to drain. In case it is not machine-finished material, thorough initial cleaning is necessary. In the case of locomotive material, such as packing rings, knuckle pins, bushings and

all finished parts, whether made on shop order or for stock, and not immediately applied, treatment with the No-Ox-Id compound is required.

Referring to the illustration, a convenient type application tank is illustrated. It consists of an inner tank 12 in. by 2 ft. 8 in. by 3 ft. high, suitably supported in an outer tank 20 in. by 3 ft. 2 in. by 3 ft. high. The inner tank rests on four wooden blocks 2 in. above the bottom of the outer tank which is supported on 1 3/4-in. by 5-in. wooden blocks on the shop floor. The material used in making the tanks is 18-gage galvanized iron.



Especially designed vat for applying No-Ox-Id compound

All seams are riveted and soldered, each tank being water-tight. The inner tank is permanently positioned with regard to the outer tank by means of ten 1/16-in. by 3/4-in. straps or ties, the method of flanging the tanks and applying these ties being shown in detail in the drawing.

A 1/2-in. water pipe and valve are provided for filling the space between the inner and outer tanks, and a steam line, also 1/2 in. in size and applied as shown, heats the water and the No-Ox-Id bath in the inner tank to the required temperature. A trap is indicated in the steam line for drainage purposes, but this is not necessary if the discharge is connected to the shop service drain.

Aluminum Tire Gage

AN aluminum tire gage, designed and made at the Chicago shops of the Chicago & North Western for calipering driving-wheel tires and wheel centers, is shown in the illustration. The gage frame, as well as the sliding arms, was cast at the Chicago shops' foundry, the melt consisting of scrap aluminum. Owing to the

use of this material, as well as the T-section frame with graduated holes in the web, the gage is unusually light, weighing only 17 1/2 lb. There is practically no spring in this gage, and this fact, in conjunction with the light weight, promotes a sensitive "feel" of the gage and accurate calipering. These characteristics are noticeably absent from many of the wood-frame gages now in use, and steel-frame gages are generally too heavy to be entirely satisfactory.

By referring to the illustration, the detailed construction of the gage will be apparent. The frame is made 8 ft. 3 in. long to accommodate the largest tires. The flange of the T-section is 2 1/8 in. wide and the web 3 in. high at the center and 2 3/8 in. high at each end. The holes drilled in the web to reduce the weight are graduated in size from 1 1/8 in. in diameter at the center to 3/4 in. at each end. The aluminum arm and steel point, at the left end, are held in position on the gage frame by means of four countersunk head screws firmly set into the frame flange. The aluminum arm at the right end of the gage slides on the flange of the gage frame and is held in any desired position, depending upon the size of the tire being calipered, by means of four thumb screws. Final adjustment to the exact size of the driving-wheel tire diameter is obtained by the steel point with a knurled round end for turning, and hand adjustment by means of a threaded fit in the arm. Once set, this adjustable steel point is held positively in position by means of a knurled collar and taper locking nut.

V-Belts for Multi-V-Drives

AN improved type of Goodyear Emerald cord V-belt has been made available by the Worthington Pump & Machinery Corporation, Harrison, N. J., for application to multi-V-drives for which high power capacity, long flexing life, uniform cross-section and low stretch are claimed. This belt is made in two styles, one having endless cord in one plane, and the other two endless cords in two planes. All cords are completely embedded in rubber, thus affording full insulation for the control of internal heat.

The tension and compression sections of the belt are composed of rubber, with layers of fabric distributed through the compression section to prevent excessive flexibility.

The belt is molded to shape and is completely enclosed in a fabric envelope which protects the working elements and provides a good contact surface for the V-grooved sheave. The fabric for the envelope is so cut that the threads run on the "bias." This prevents the envelope from taking any part of the load, thus protecting it from rupture. A smooth, unbroken surface on the contact faces minimizes the possibility of fraying.



A light-weight, rigid tire gage made of aluminum

Pneumatic Drilling Devices

WHERE large numbers of locomotive side rods are handled the accompanying illustration, Fig. 1, shows a convenient and efficient pneumatic drill press fastened to the rod bench that eliminates handling the rods to and from the radial drill press with an overhead traveling crane.

A pneumatic hoist is placed in a convenient location where it is accessible for use in lifting the rods to the drill as shown, for drilling the keeper bolt holes as well as the compression grease cup holes. The drill is also used for tapping threads for the keeper bolt in new side

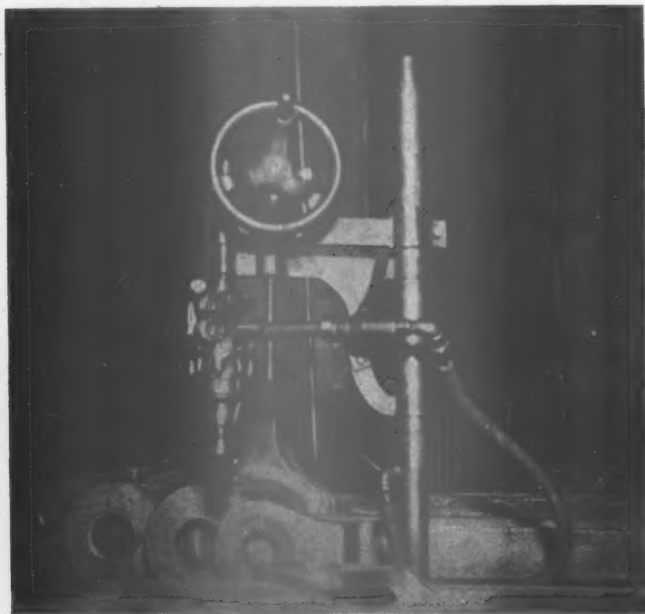


Fig. 1—Locomotive rods can be drilled with this device without unnecessary handling

rods. One mechanic handles the rods and drills all holes without the aid of a helper, thereby cutting the cost of drilling and handling to a minimum, also increasing production.



Fig. 2—The foot-operated drill for miscellaneous drilling operations

The illustration shows clearly how simple the framework is that supports the heavy duty pneumatic drill. The frame member is made to move up and down on the steel post by means of the hand wheel fastened to the adjustable stationary arm. The hand wheel is connected to the feed screw by two bevel gears, thus forcing the drill up and down by simply rotating the hand wheel in the desired direction.

Fig. 2 illustrates another pneumatic toolroom drill that is lever operated. This drill is of practically the same design as that used for drilling holes of small diameter up to $\frac{1}{2}$ -in., and is located at the toolroom window where the attendant can drill small pins and other parts without interrupting other work in the machine shop. The drill in Fig. 1 is operated by a throttle valve which is an integral part of the drill. The toolroom drill is operated by a foot throttle valve. The operator holds the work with his left hand and operates the lever with his right, thereby controlling the movement or rotation of the drill with his foot.

The drill can be moved up and down on the column as desired. It is locked in position by means of a thumb screw located in the top section of the hand lever adjustable collar. The framework for these drills can be constructed right in the toolroom and the conventional type of air motor or drill used in the frame.

Rack for Storing Throttle Assembly

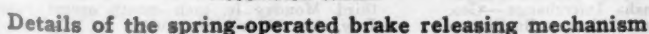
WHEN locomotives are in the shop undergoing repairs the throttle and power reverse gear assembly should be removed and sent to the machine shop



A finished part rack which combines orderliness and ease of inspection

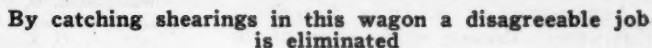
The rack shown in the illustration is used for storing the throttle assembly after it has been completely reconditioned and is ready for replacement on the engine. It affords the general foreman ample opportunity to inspect all of the parts during his various tours of inspection and insures having a completely assembled throttle or power reverse gear available at all times for application to engines when needed. It also eliminates damage to the parts after they are repaired account of heavier material being piled on them if allowed to remain on the floor or bench of the machine shop.

INE of the eastern railroads has a class of switching locomotives on which some difficulty has been experienced in quickly effecting the release of driver brakes. These particular locomotives are older road engines which have been assigned to switching service. The drawings accompanying this article show the details of a device which has been applied to the locomotives that has successfully overcome the trouble. Essentially it consists of a coil spring arrangement in which the spring is compressed when the brake cylinder push rod is forced



A spring seat and guide *A* made of 3½-in. pipe is welded to the boiler brace immediately back of the driver brake cylinder. A clevis *F* and pin *C* are attached to the top driver brake lever-cylinder connection and, by means of the threaded push rod *E*, which is long enough to project through the brace sheet when the brakes are released, the spring assembly is compressed when the application is made. Double nuts, both at the spring end of the threads and at the brake cylinder end, permit the necessary adjustments to be made to assure the proper functioning of the device.

PICKING up shearings of tin from the floor of the tin shop is considered a hazardous task for the reason that many slivers of tin are liable to injure the person handling them unless great care is exercised. The tin shop foreman on one railroad designed a scrap



The wagon shown in the photograph is made of heavy gage sheet tin, the size to be governed by the type of shear used. It is mounted on 18 in., diameter wheels and equipped with a pipe handle, set at an upward angle to prevent the scrap from piling too close to the laborer's hands when moving it to the scrap car.

AN all-purpose aluminum welding flux, Oxweld aluminum flux, has been placed on the market by the Linde Air Products Company, 30 East Forty-Second street, New York. This flux is intended to replace the two fluxes previously marketed, one for welding pure aluminum and the other for welding aluminum alloys. The new flux is suitable for welding both metals.

Among the Clubs and Associations

TORONTO RAILWAY CLUB.—"Mass Movement" was the subject discussed by A. A. Gardiner, assistant general passenger traffic manager of the Canadian National, before the meeting of the Toronto Railway Club held at the Royal York Hotel on October 6.

CANADIAN RAILWAY CLUB.—The Hon. Wesley Frost, Consul General for the United States in Canada, will discuss "Crime in the United States" at the meeting of the Canadian Railway Club to be held in the York Room of the Windsor Hotel, Montreal, at 8 p. m., October 16.

RAILWAY CLUB OF PITTSBURGH.—At the September 28 meeting of the Railway Club of Pittsburgh, which was held at the Fort Pitt Hotel, Pittsburgh, Pa., Lawrence Richardson, mechanical assistant to the vice-president and general manager of the Boston & Maine, presented a paper on "An Analysis of Equipment Repairs."

PACIFIC RAILWAY CLUB.—At the annual meeting of the Pacific Railway Club to be held at 7:30 p. m. on October 13 at Sacramento, Cal., V. Villette, Pacific coast manager of the Westinghouse Air Brake Company, will discuss the new AB brake. Motion pictures and slides of tests of the AB brake will be shown.

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS & SOUTH OMAHA INTERCHANGE.—"The Interchanging of Cars in the Terminal" will be discussed by N. A. Johnson, general car foreman of the Chicago, St. Paul, Minneapolis & Omaha, before the meeting of the Car Foremen's Association of Omaha to be held at 1:15 p. m. on October 12 at the Omaha, Neb., depot of the Chicago, Burlington & Quincy.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Because of the effect of the depression on the railroads and the fact that no work has been done by the committees, the Association of Railway Electrical Engineers will hold no convention this year. The executive committee will hold its regular session at the Hotel Sherman in Chicago, on October 19, to handle the association business and elect officers.

WESTERN RAILWAY CLUB.—The initial fall meeting of the Western Railway Club will be held on Monday evening, October 16, at the Hotel Sherman, Chicago, the speaker of the evening being R. L. Lockwood, Director, Section of Purchases, Federal Co-ordinator of Transportation. Mr. Lockwood will discuss the subject "Railroad Purchases and Standardization." As this subject is one of unusual interest and importance, particularly at the present time, it is anticipated that a large number of railway officers and supply-company representatives will be present to hear the address and take part in the subsequent discussion. The usual "Dutch-treat" dinner will be served at 6:30 p. m.

CHICAGO CAR FOREMEN'S ASSOCIATION.—Meeting held Monday evening, September 11, at the Bismark Hotel, Chicago. Subject, "The Vital Influence of Modern Braking in Freight Service." Speakers, L. K. Silcox, vice-president, New York Air Brake Company, Watertown, N. Y., and C. A. Campbell, engineer of tests. ¶ At this, the first meeting of the association for the 1933-1934 season, a large attendance of well-known mechanical-department heads and car supervisors was present, owing to the prominence of the speakers and the great interest in the new brake which has been in the process of development and test during the last three years. Mr. Silcox discussed in general the functions of the new brake and its economic advantages as applied to modern freight equipment, and Mr. Campbell described the brake in detail, using carefully-selected charts and diagrams. A moving picture illustrating tests of the new brake was shown at the conclusion of Mr. Campbell's paper.

Directory

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION.—T. L. Burton, Room 2205, 150 Broadway, New York.

ALLIED RAILWAY SUPPLY ASSOCIATION.—F. W. Venton, Crane Company, Chicago.

AMERICAN RAILWAY ASSOCIATION.—Division V.—MECHANICAL.—V. R. Hawthorne, 59 East Van Buren street, Chicago.

Division V.—EQUIPMENT PAINTING SECTION.—V. R. Hawthorne, Chicago.

Division VI.—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey street, New York.

Division I.—SAFETY SECTION.—J. C. Caviston, 30 Vesey street, New York.

Division VIII.—CAR SERVICE DIVISION.—C. A. Buch, Seventeenth and H streets, Washington, D. C.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet avenue, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth street, New York.

RAILROAD DIVISION.—Marion B. Richardson, Room 332, 30 Church street, New York.

MACHINE SHOP PRACTICE DIVISION.—R. E. W. Harrison, 6373 Beechmont avenue, Mt. Washington, Cincinnati, Ohio.

MATERIALS HANDLING DIVISION.—M. W. Potts, Alvey-Ferguson Company, 1440 Broadway, New York.

OIL AND GAS POWER DIVISION.—Edgar J. Kates, 1350 Broadway, New York.

FUELS DIVISION.—W. G. Christy, Department of Health Regulation, Court House, Jersey City, N. J.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Job. A. Andreucetti, C. & N. W. Station, Chicago.

CANADIAN RAILWAY CLUB.—C. R. Crook, 2276 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month except in June, July and August at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT OFFICERS ASSOCIATION.—A. S. Sternberg, master car builder, Belt Railway of Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month except June, July and August, Bismark Hotel, Chicago, Ill.

CAR FOREMEN'S ASSOCIATION OF OMAHA, Council Bluffs and South Omaha Interchange.—Geo. Krieger, car foreman, Chicago, Burlington

& Quincy, Sixteenth avenue and Sixth street, Council Bluffs, Iowa. Regular meetings, second Thursday of each month at Council Bluffs.

CENTRAL RAILWAY CLUB OF BUFFALO.—M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meeting, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

CLEVELAND RAILWAY CLUB.—F. B. Frericks, 14416 Alder avenue, Cleveland, Ohio. Meeting second Monday each month, except June, July and August, at the Auditorium Hotel, East Sixth and St. Clair avenue, Cleveland.

EASTERN CAR FOREMEN'S ASSOCIATION.—E. L. Brown, care of the Baltimore & Ohio, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

INDIANAPOLIS CAR INSPECTION ASSOCIATION.—R. A. Singleton, 822 Big Four building, Indianapolis, Ind. Regular meetings first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m. Noon-day luncheon, 12:15 p. m. for Executive Committee and men interested in the car department.

INTERNATIONAL RAILROAD MASTER BLACKSMITH'S ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—T. D. Smith, 1660 Old Colony building, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabasha street, Winona, Minn.

MASTER BOILERMAKERS' ASSOCIATION.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meeting, second Tuesday in each month, excepting June, July, August and September. October and November meetings to be held at University Club, Boston.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July and August, at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meeting first Monday each month, except June, July and August, at Minnesota Transfer Y. M. C. A. Gymnasium building, St. Paul.

PACIFIC RAILWAY CLUB.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately.

RAILWAY CAR MEN'S CLUB OF PEORIA AND PEKIN.—C. L. Roberts, R. F. D. 5, Peoria, Ill.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1941 Oliver building, Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August, Ft. Pitt Hotel, Pittsburgh, Pa.

RAILWAY FIRE PROTECTION ASSOCIATION.—R. R. Hackett, Baltimore & Ohio, Baltimore, Md. Annual meeting October 17-18, Hotel Stevens, Chicago.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.—J. D. Conway, 1841 Oliver building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, American Railway Association.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings third Thursday in January, March, May, July, September and November. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

SUPPLY MEN'S ASSOCIATION.—E. H. Hancock, treasurer, Louisville Varnish Company, Louisville, Ky. Meets with Equipment Painting Section, Mechanical Division American Railway Association.

TORONTO RAILWAY CLUB.—N. A. Walford, district supervisor car service, Canadian National, Toronto, Ont. Meetings first Friday of each month except June, July and August.

TRAVELING ENGINEER'S ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth street, Cleveland, Ohio.

WESTERN RAILWAY CLUB.—C. L. Emerson, 822 Straus Building, Chicago. Regular meetings third Monday in each month except June, July, August and September.

NEWS

THE GRAND TRUNK WESTERN has placed an order with the Timken Roller Bearing Company for trailer bearings for use under five of its locomotives.

THE LEHIGH & NEW ENGLAND has authorized the dismantling of 273 box cars of 30 tons' capacity and 62 box cars of 40 tons' capacity, and has sold for dismantling 33 hopper cars of 50 tons' capacity and 197 gondola cars of 40 tons' capacity.

THE DELAWARE, LACKAWANNA & WESTERN has ordered three Diesel oil-electric locomotives in addition to the nine reported in the July issue of the *Railway Mechanical Engineer*. Eight of these locomotives are now being built by the American Locomotive Company at Schenectady, N. Y., and four by the Ingersoll-Rand Company at Phillipsburg, N. J.

CHICAGO, BURLINGTON & QUINCY.—The Edward G. Budd Manufacturing Company has placed with the Timken Roller Bearing Company an order for all roller journal bearings to be used under the stream-lined passenger train, which the Budd Company is building for this railroad.

THE LOUISVILLE & NASHVILLE has sold 4,380 units of obsolete and depreciated rolling stock to be dismantled and disposed of as scrap. Included in the sale were 251 locomotives, 3,671 freight cars and 368 units of work equipment—all obsolete stock of small capacity unsuitable for service in modern trains. The cars were of various classes of wooden equipment. The original cost of the entire lot was approximately \$7,000,000, but this value had been largely depreciated at the time of the sale.

A. R. A. Sample Cars Delivered

THE FIVE SAMPLE steel-sheathed, wood-lined 50-ton box cars of the new A. R. A. type of construction adopted as standard in 1932 have been completed by the Pressed Steel Car Company at its McKees Rocks, Pa., plant. These are the cars which were ordered by the American Railway Association from the American Railway Car Institute in March of this year. They are nearly two tons lighter in weight than the steel-sheathed, wood-lined box cars of similar capacity, which were designed by the Committee on Car Construction in 1923 but never adopted as standard, although approximately 70,000 cars have been built from this basic design. The inside dimensions of the new cars are: Length, 40 ft. 6 in.; width, 8 ft. 9½ in., and height, 9 ft. 4 in., the width and height being the largest possible in a car for generally unrestricted interchange service. The cars will now be subjected to rigid tests by the American Railway Association in co-operation with the various railroads to determine whether there may be any possible weaknesses in the structure. The Car Construction Company is now studying the possibility of bringing about a further reduction in the weight of cars of this design by the use of light-weight alloys without unwarranted first cost for such material.

Increases in Shop Employment Continue

Boston & Maine.—The number of workmen employed in the repair shops of the Boston & Maine were increased by 205 men during September. The September employment in the railroad shops at Billerica, Mass., and at Concord, N. H., and at Keene totaled 1,166 men, as compared with 961 in August, with an increase in appropriation for the shops of \$38,682.

The principal increase was at the Concord, N. H., car shops, where a total of 480 men were at work, as compared with 316 employed there in August. All of the increase of 164 men was in the freight car repair shops, where additional employment for more men will be provided as the railroad further progresses its recently announced program of 100,000 man-hours of labor for workmen who have been practically idle for the past two years. This is being made possible by the new repair program calling for an expenditure of approximately \$400,000 in rebuilding 500 gondola coal cars. The passenger car repair shops at Concord worked the same schedule as in August, when 220 men worked a staggered schedule of three-quarters time.

At Billerica locomotive repair shops 650 men were called in September for full time of 22½ working days, as compared with 570 men in August. At the Keene, N. H., shops three-quarters of the normal force continued to work the full month, or 22½ working days, with the same number of men employed as in August.

Chicago, Burlington & Quincy.—The shops of the C., B. & Q. at Havelock, Neb., were opened on full time on September 11.

Maine Central.—During September there was an increase in the number of men employed at the Waterville, Me., shops. The shops worked full time, or 26 working days, during September, and a

total of 300 workmen were employed as compared with 273 in August. The increase, Executive Vice-President D. C. Douglass said, was necessitated by an increase in the railroad's traffic with consequent need for additional equipment.

New York Central.—During September the N. Y. C. planned to employ in its repair shops five per cent more men than it employed in August and 29 per cent more than in July. The total number of workers increased 388, rising from 7,825 employed in August to 8,213 in September. The allotments of labor were as follows: Locomotive shops, 152 days and 4,849 men; freight car shops, 120 days and 2,182 men; passenger car shops, 62 days and 1,182 men. These increases were made from a desire to aid in the national recovery program as well as to take care of expected increases in traffic this fall and winter. Up to August 5, the New York Central Lines had added in all departments a total of 19,341 employees since June 1. A tentative program outlining increased employment during October, both in days and in number of men in its shops, dependent on business conditions, calls for the employment of 9,550 men, an increase of 1,337 or 16 per cent over the 8,213 employed in September, and an increase of 1,725 or 21 per cent over the 7,825 employed in August. The allotment of labor will be as follows: Locomotive shops, 165 days, 6,199 men; freight car shops, 128 days, 2,125 men; passenger car shops, 84 days, 1,226 men.

Pennsylvania.—Ten thousand additional men have been put to work on the Pennsylvania since June 1, according to a statement of President W. W. Atterbury in a radio address on September 3, under the auspices of the National Recovery Administration.

Union Pacific.—On September 1 the working time of 2,019 shopmen was increased by placing locomotive and car repair shops at various points on its lines on a working program of 160 hours a month. Shops affected by the order were at Omaha, Neb.; Valley, Columbus, Grand Island, Kearney and Sidney, Rawlins, Wyo., and Cheyenne, Denver, Colo.; Ellis, Kans.; Pocatello, Ida., and Los Angeles, Cal. It was estimated that this move



New York City & Northern Railroad Locomotive built in 1880—Cylinders, 15 in. by 22 in.; drivers, 48 in.

would add \$100,000 a month to the operating expenses of this company.

THE DELAWARE, LACKAWANNA & WESTERN is installing a Whiting drop pit table at Secaucus, N. J.

THE CHICAGO, ROCK ISLAND & PACIFIC has awarded a contract to the T. S. Leake Construction Company, Chicago, for the reconstruction of the roof over 32 stalls of this company's 49-stall enginehouse at Cedar Rapids, Iowa.

NEW YORK, NEW HAVEN & HARTFORD.—A special-car club has recently equipped three club cars operating on this road with air conditioning control of the Airtrol system furnished by the Rails Company, New York. This equipment is for year-round operation.

CLASS I RAILROADS in the first eight months of 1933 placed in service 1,838 new freight cars, according to the Car Service Division of the American Railway Association. In the same period last year, 2,477 new freight cars were placed in service. The railroads on September 1 this year had 1,129 new freight cars on order compared with 1,423 on the same day last year. The railroads placed one locomotive in service in the first eight months this year compared with 35 in the same period in 1932. New locomotives on order on September 1 this year totaled one compared with five on the same day last year. Freight cars and locomotives leased or otherwise acquired are not included in the above figures.

THE ALLEGHENY REGIONAL ADVISORY BOARD has sent a questionnaire to producers, consumers, etc., which affords shippers the opportunity to place before the railroads their particular car-equipment problems. The questionnaire is designed to reveal the actual need for such cars as the movable roof box car, the hopper or drop-bottom box car with side doors, covered hopper cars, covered gondola cars and containers. The questions asked are: Have you need for a car of this description? To what extent are you now using this type of car? If not, can you use them and for what materials?

New Tourist Sleeping Cars on Great Northern

A NEW TYPE of tourist sleeping car has been adopted by the Great Northern as another move in its campaign to regain business lost to the private automobile and the buses. Recently the road introduced two-cents-a-mile fares on a system-wide basis.

The new cars have 16 lower berths and uppers, with large dressing and smoking rooms at each end. The seats are richly upholstered, each berth has individual lights, and other appointments are very similar to those in standard Pullman cars. The first of the new cars was on the Empire Builder out of St. Paul, Minn., on August 26, and the eight trains operated in the Pacific coast service are now carrying the new equipment.

E. H. Wilde, Great Northern general passenger agent, believes the recent moves will go far toward increasing the popularity of train travel. Day coach passengers also are privileged to buy berths for the night in the tourist sleepers.

Supply Trade Notes

R. L. GIEBEL has been appointed representative in the New York metropolitan district for the Morton Manufacturing Company, Muskegon Heights, Mich., manufacturers of railroad shapers and allied equipment. Mr. Giebel's headquarters are at 1501 Undercliff avenue, New York City.

THE LOCOMOTIVE APPLIANCE INSTITUTE has been organized for the purpose of formulating a code for submission to the National Recovery Administration on behalf of manufacturers of locomotive appliances. J. F. Farrell of the Nathan Manufacturing Company, 250 Park avenue, New York, has been elected president of the new organization.

EMMETT K. CONNEELY, formerly vice-president of the Standard Steel Car Company, with headquarters at Chicago, has been appointed manager of railroad sales of the Republic Steel Corporation, with headquarters at Youngstown, Ohio. Mr. Conneely served in various capacities with the Pittsburgh & Lake Erie during his early business life, joining the Standard Steel Car Company during the war. He was later connected with the New York Air Brake Company as vice-president, and became vice-president of the Pullman Company at New York upon that company's acquisition of the Standard Steel Car Company. He was subsequently made vice-president of the Standard Steel Car Company at Chicago, which position he held until March, 1933.

MAURICE N. TRAINER, assistant vice-president of the eastern sales department of the American Brake Shoe & Foundry Company, New York, has been elected vice-president. After graduating from the University of Pennsylvania in 1910, Mr.

Brake Shoe Company. He returned to the Brake Shoe sales department in 1927 and was appointed assistant vice-president of the eastern sales department in 1928.

WILLIAM E. MILLHOUSE is now president of the Burden Iron Company, Troy, N. Y. Prior to his election Mr. Millhouse had been executive vice-president, while the position of president remained vacant since the death of James A. Burden on June 1, 1932.

E. D. CAMPBELL, in charge of the American Car & Foundry Company's engineering department at St. Louis, Mo., has been appointed assistant general mechanical engineer, with headquarters at Berwick, Pa. In his new position, Mr. Campbell is second in charge to V. R. Willoughby, gen-



E. D. Campbell

eral mechanical engineer of A. C. F. The promotion of Mr. Campbell, who, until September 1, had been located at St. Louis since 1920, occurs in connection with further concentration of A. C. F. engineering activities at Berwick; events have proved, the announcement states, that the redistribution of the A. C. F. engineering personnel has proved most satisfactory, both from the standpoint of the company and its customers. Allen W. Clarke, mechanical engineer, succeeds Mr. Campbell at St. Louis, while General Mechanical Engineer Willoughby continues to divide his time between the general office in New York and the Berwick branch of the engineering section.

Obituary

HENRY MUHLENBERG SPERRY, publicity representative of the Union Switch & Signal Company and the General Railway Signal Company, died on September 2 at his home in New York City.

JAMES A. CAMPBELL, chairman emeritus of the Youngstown Sheet & Tube Company and a prominent figure in the steel industry for more than 40 years, died suddenly of a heart attack at his home in Youngstown, Ohio, on September 20, at the age of 79. Mr. Campbell was one of the incorporators of the company and was its president from 1906 to 1930, and then to 1931 chairman of the board.

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Maurice N. Trainer

Trainer entered the employ of the Public Service Railway Company of New Jersey (now the Public Service Co-ordinated Transport), where he remained until January 1, 1916, when he became service inspector for the American Brake Shoe & Foundry Company. In 1926 he was elected vice-president of a subsidiary company, American Malleables Company, and also vice-president of the American Brakeblok Corporation, automotive subsidiary of the

AN EPIDEMIC *Of Forging Failures* HALTED BY REPUBLIC



Every time the temperature dropped, forging failures increased. Research showed that ordinary forging steels are seriously affected by cold weather. They become brittle. » » » This problem has now been successfully solved by Agathon Alloy Steels that perform regardless of atmospheric conditions. » » » These steels are made tough to withstand the shocks of railroad service and they stay tough no matter how the thermometer drops. » » » Whether it be springs, rods, axles, motion work, pins, tubes or staybolts, Republic Steel Corporation has carefully worked out a material specifically to meet the conditions of modern railroading; a material that will be stronger and last longer. » » » Wherever you use iron or steel, consult Republic Steel Corporation for better materials.

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REPUBLIC STEEL
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GENERAL OFFICES  YOUNGSTOWN, OHIO



Toncan Iron Boiler Tubes, Pipe, Plates, Cast-
ings, Rivets, Staybolts, Tender Plates and
Firebox Sheets • Sheets and Strip for spe-
cial railroad purposes • Agathon Alloy
Steels for Locomotive Parts • Agathon En-
gine Bolt Steel • Agathon Iron for pins and
bushings • Agathon Staybolt Iron • Climax
Steel Staybolts • Upson Bolts and Nuts •
Track Material, Money Guard Rail Assem-
blies • Enduro Stainless Steel for dining car
equipment, for refrigeration cars and for fire-
box sheets • Agathon Nickel Forging Steel.
The Birdsboro Steel Foundry & Machine
Company of Birdsboro, Pa. has manufac-
tured and is prepared to supply under
license, Toncan Copper Molybdenum iron
castings for locomotives.



Personal Mention

General

OTTO JABELMANN, superintendent of shops of the Union Pacific at Omaha, Neb., has been appointed assistant general superintendent motive power and machinery in charge of the car department, with headquarters at Omaha.

C. A. GILL, superintendent of motive power and rolling equipment of the Reading Company, has had his jurisdiction extended to include the Central of New Jersey, succeeding C. E. Chambers, who has been granted a leave of absence. A biographical sketch of Mr. Gill's career appeared in the September, 1932, *Railway Mechanical Engineer* in connection with the announcement of his appointment as superintendent of motive power and rolling equipment for the Reading.

GROVER CLEVELAND NICHOLS has been appointed general superintendent of the Alabama, Tennessee & Northern, with headquarters at York, Ala. Mr. Nichols was born on September 19, 1885, at Jonesboro, Ark. He attended the elementary



Grover Cleveland Nichols

and high schools and entered railroad service in June, 1901, as call boy for the St. Louis Southwestern at Jonesboro. He served consecutively with that road until 1908 as call boy, timekeeper, storekeeper, and machinist apprentice. He was then appointed machinist at Pine Bluff, Ark., and in 1910 became master mechanic of the Jonesboro, Lake City & Eastern (St. Louis-San Francisco). From October, 1912, to August, 1913, Mr. Nichols was shop foreman of the St. Louis Southwestern. He entered the service of the Alabama, Tennessee & Northern as master mechanic during August, 1913, and in May, 1918, was promoted to the position of superintendent of motive power and equipment. He became superintendent of the A. T. & N. in June, 1920.

E. J. COLE, assistant general superintendent motive power and machinery of the Union Pacific System at Omaha, Neb., has been appointed assistant general superintendent motive power and machinery in charge of the locomotive department, with headquarters at Omaha. Mr. Cole has been connected with the mechanical department of the Union Pacific for 25

years. He was born on November 17, 1894, at Cheyenne, Wyo., and entered the service of the Union Pacific on January 25, 1908, as a machinist apprentice at Cheyenne, then serving successively as a



Emmett J. Cole

machinist, machine inspector, erecting gang foreman and district foreman. He was appointed superintendent of shops at Cheyenne on September 15, 1923, and on August 1, 1925, was transferred to Omaha. On January 1, 1929, Mr. Cole was promoted to assistant to the general superintendent motive power and machinery of the Union Pacific System, which position he held until October, 1931, when he was made assistant general superintendent motive power and machinery.

J. W. HIGHLEYMAN, general superintendent motive power and machinery of the Union Pacific System, has retired. Mr. Highleyman was connected with the Union Pacific continuously for 40 years except for a short period during the World War when he was in army service. Mr. High-



J. W. Highleyman

leyman was born in West Virginia in 1868, and after serving as a machinist on the Missouri Pacific at Sedalia, Mo., he entered the service of the Union Pacific in 1893 in the shops at Armstrong, Kan. In 1895 he was advanced to foreman and later served as master mechanic on the Kansas and Wyoming division. In 1918 he left

railroad service to enter the mechanical department of the United States Army in France where he subsequently was advanced to the rank of major. Mr. Highleyman returned to the Union Pacific in 1919 as a master mechanic at Cheyenne, Wyo., being promoted to superintendent of shops with the same headquarters in 1922. In the following year he was promoted to assistant superintendent motive power and machinery of the Union Pacific Railroad, with headquarters at Omaha, Neb., then being transferred to the Oregon Short Line in 1928 with headquarters at Pocatello, Ida. He was further promoted to assistant general superintendent motive power and machinery on the Union Pacific System in October, 1930, in which position he had jurisdiction over the Oregon Short Line, the Oregon-Washington Railroad & Navigation Company and the Los Angeles & Salt Lake, with headquarters at Pocatello. He held this position until October, 1931, when he was advanced to general superintendent of motive power and machinery of the system with headquarters at Omaha.

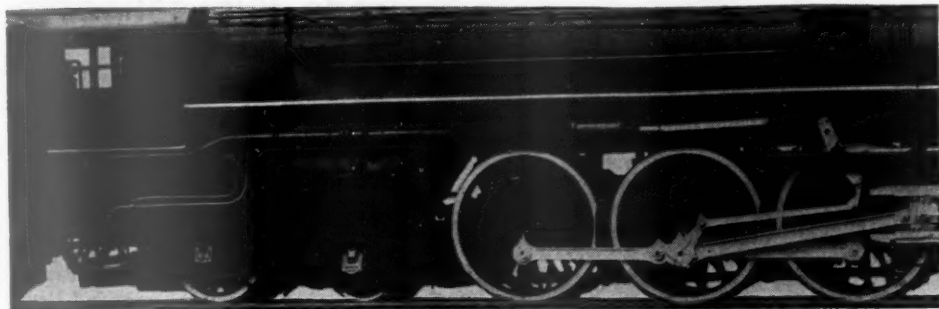
J. W. BURNETT, assistant general superintendent motive power and machinery of the Union Pacific System at Pocatello, Idaho, has been promoted to general superintendent of motive power and machinery with headquarters at Omaha, Nebr., to succeed J. W. Highleyman. Mr. Burnett has been in the service of the Union Pacific for 21 years. He was born at



J. W. Burnett

McCook, Neb., in 1890 and entered railway service in 1905 as a steam-hammer operator on the Chicago, Burlington & Quincy at McCook. In 1912 he went with the Union Pacific as a machinist apprentice at Cheyenne, Wyo., and in the following year was advanced to foreman at Kearney, Neb., holding this position until 1917 when he was further advanced to district foreman at Laramie, Wyo. In 1921 Mr. Burnett was promoted to master mechanic at Green River, Wyo., and in the following year was transferred to Cheyenne. From August to December, 1928, he served as assistant superintendent of motive power and machinery at Omaha, and at the end of this period was made superintendent of motive power and machinery with the same headquarters. In 1930

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BY DESIGNING a six driver engine with ample boiler capacity plus The Locomotive Booster instead of an eight wheel without the Booster we saved at least 2c. per mile in maintenance.

—Operating Vice-President of Large Railroad



The Locomotive **BOOSTER** SAVES MAINTENANCE EXPENSE

The Locomotive Booster serves railroads in two definite capacities—as a power unit and as a means to reduce maintenance.

Primarily, it offers the most economical method of securing extra power to increase gross ton miles per hour. It is one of the important elements that make Super-Power Locomotives the efficient power plants they are today.

On road engines, the Booster gives the added punch that gets underway heavy trains the locomotive can handle at speed. It speeds up passenger, freight and yard service. It gives power when most needed—for starting, accelerating, and to maintain speed on heavy grades. Not required at road speeds, it is cut out. Maximum operating economy results from capitalizing idle weight and spare steam.



FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK

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Mr. Burnett's title was changed to assistant general superintendent motive power and machinery and in October, 1931, he was transferred to Pocatello, Ida.

Master Mechanics and Road Foremen

H. N. SMITH, master mechanic of the Prince Albert and Saskatoon divisions of the Canadian National, has been appointed master mechanic of the Saskatoon division.

J. E. MITCHELL, master mechanic of the Melville division of the Canadian National, has been appointed master mechanic of the Prince Albert division.

JOSEPH D. KILIAN has been appointed master mechanic of the Wyoming division of the Union Pacific at Cheyenne, Wyo.

Shop and Enginehouse

JOHN GOGERTY, master mechanic of the Wyoming division of the Union Pacific, with headquarters at Cheyenne, Wyo., has been appointed superintendent of shops at Omaha, Neb., to succeed Otto Jabelmann. Mr. Gogerty was born at Decatur, Ill., on January 20, 1884. He began his railroad career as a foreman on the Wabash at Decatur on January 1, 1909. He entered the service of the Union Pacific on June 1, 1918, as a foreman at Armstrong, Kan., later working in similar capacities at Marysville, Kan., and Junction City. On January 1, 1921, he became district foreman at Salina, Kan., and later held similar positions at Junction City and Laramie, Wyo., serving also for a time as general foreman at Armstrong. On March 19, 1925, he was promoted to the position of master mechanic at Green River, Wyo., and on August 1, 1928, became master mechanic at Cheyenne.

Purchasing and Stores

JOHN H. LAUDERDALE, general purchasing agent of the Gulf Coast Lines and the International-Great Northern, with headquarters at Houston, Tex., has been promoted to general purchasing agent of all the Missouri Pacific lines, with headquar-



John H. Lauderdale

ters at St. Louis, Mo. Mr. Lauderdale has been connected with the Missouri Pacific and its subsidiaries for 28 years. He entered the service of the Gulf Coast Lines in 1905 as chief clerk to the vice-president and general manager, later becoming treasurer and purchasing agent. In June, 1918, he was appointed to the

staff of the director of purchases and stores of the United States Railroad Administration and from 1920 to 1924 served successively as assistant manager and manager of liquidation of the U. S. R. A. In July, 1924, he returned to railroad service as general purchasing agent of the International-Great Northern and, when the I.-G. N. and the Gulf Coast Lines became parts of the Missouri Pacific Lines late in 1924, was appointed general purchasing agent of both properties.

W. R. H. MAU, assistant purchasing agent of the Gulf Coast Lines and the International-Great Northern, has been appointed purchasing agent of these lines with headquarters at Houston, Tex. Mr. Mau will assume the duties formerly discharged by John H. Lauderdale.

WILLIAM A. HOPKINS, general purchasing agent of the Missouri Pacific Lines, has been appointed to the newly-created position of consulting purchasing agent, with headquarters as before at St. Louis, Mo. Mr. Hopkins was born on September 24, 1871, at Moline, Ill. He commenced his business career in 1889 and for the next 10 years was engaged in the construction of electrified street railways in various cities, except for the period from 1891 to 1894 when he was in the employ of the Chicago World's Fair commissioners. In 1899 Mr. Hopkins went with the C. M. Wilmerding Consulting Engineering Company, Chicago, as erecting engineer in charge of the construction of



William A. Hopkins

the electrical and mechanical apparatus in the shops of the Chicago, Burlington & Quincy at Hannibal, Mo. From 1905 to 1909 he was with the Wabash, first as electrical and mechanical engineer in charge of the construction of the shops at Decatur, Ill., and then as engineer in charge of all electrical power apparatus on the Wabash. He then went with the Safety Car Heating & Lighting Company and in 1911 entered the service of the Missouri Pacific as supply agent. During the World War Mr. Hopkins was manager of the Procurement division of the Southwest region of the United States Railroad Administration, later being appointed supervisor of stores for the same region. When the railroads were returned to private operation he was again appointed supply agent for the Missouri Pacific which position he held until 1923 when he was appointed general purchasing agent.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

VALVES.—The New York Air Brake Company, 420 Lexington avenue, New York, in Leaflet No. 2356 gives instructions on the use of condemning gages for Type K triple valves.

CORK COVERING.—Specifications for Mundet Jointite cork covering for low-temperature pipe lines (brine, ammonia and ice water) are given in the Price List issued by the Mundet Cork Corporation, 450 Seventh avenue, New York.

WELDING EQUIPMENT.—Bulletins Nos. 1056 and 1057 on shunt inductor welder motor-generator sets and on arc welding accessories and clothing, respectively, have been issued by the Universal Power Corporation, 1718 Clarkstone Road, Cleveland, Ohio.

STURTEVANT AIR CONDITIONING.—The B. F. Sturtevant Company, Hyde Park, Boston, Mass., describes and illustrates in a 20-page catalog its various types of unit air-conditioning apparatus for heating and humidifying or cooling and dehumidifying in offices, homes, stores, etc.

INLAND STEEL.—A step-by-step story of how Inland Steel has progressed since the World's Columbian Exposition in 1893 until the present Century of Progress Exposition at Chicago is told in a "steel" covered booklet of 32 pages issued by the Inland Steel Company, 38 South Dearborn street, Chicago. The pages are attractively printed in red and black.

ELECTRIC WELDING TUBING.—Steel & Tubes, Inc., 223 East One Hundred Thirty First street, Cleveland, Ohio, has issued a 68-page Handbook of Electric Weld Tubing, in which will be found a brief description of the method employed under the Johnston process, together with engineering and standard practice information for purchasers and users of tubing.

BELT-MOTOR DRIVEN LATHES.—Eight sizes and types of underneath belt motor-driven lathes are described and illustrated in Bulletin No. 101-A issued by the South Bend Lathe Works, 425 East Madison street, South Bend, Ind. These lathes are of the back-gear, screw cutting type and are adaptable for machinery maintenance shop, general repair shop, automotive service shop, etc. A complete range of counter-shaft drive lathes is also shown.

NICKEL ALLOY STEEL COMPOSITIONS.—A circular chart showing the nickel alloy steel compositions and treatments required to develop yield points up to 175,000 lb. per sq. in. in section sizes varying from 1 to 12 in. has been issued by the International Nickel Company, Inc., 67 Wall street, New York. The figures are based on numerous tests and may be used as a general guide to the selection of steels for bars, shafting and forgings of single shape.